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MINERALOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND

No. 17. APRIL, 1880. Vol. IV.

I.—*On some Cornish Tin-stones and Tin-capels.*

By J. H. Collins, F.G.S.

First Paper.

THE tin ores ("cassiterite") for which Cornwall has so long been famous occur under the following conditions:—

1. As pebbles, rolled masses, or grains, in stanniferous gravels and lds (stream-tin.)

The detrital tin-ore of Cornwall may be grouped under the following ads:—

a. The tin pebbles and grains of the most ancient elevated quartz avels, such as those of "Blue Pool," in Crowan, referred to by Mr. rack,* and of St Agnes Beacon, mentioned by Messrs. Kitto and Davies.†

b. The pebbles and grains of the "Head" of angular debris—the "over-rden" of the china-clay districts. This is often found at elevations not ly considerable in themselves, but relatively, as compared with the rrounding country. It differs as a whole from the quartz gravels just ferred to, not only in being much less waterworn, but also in being nerally much coarser, some of the fragments being very large. It occurs vering killas as well as granite. Grains of tin-ore are often found widely

* See *Trans. Roy. Geol. Soc. Corn.*, Vol. ix. p. 177.

† *Ibid.* p. 196.

distributed through the subsoil in the neighbourhood of tin veins, ever where there is no "head" properly so-called. This may or may not b of the same age.

c. The ancient stanniferous valley gravels. These occur at a elevations up to nearly 700 feet, but always in situations which ar relatively low, *i.e.*, in the immediate neighbourhood of ground at a greate elevation. These deposits are now almost entirely worked out,—the have often been described, most completely, however, by the late W. Jor Henwood.*

d. As a constituent of river-gravels and sea beaches now in process o formation. The tin-ore here referred to is generally in fine particles— often angular or sub-angular. Where it is the result of natural processes of denudation, and consequently produced with extreme slowness,—as o some of the isolated beaches near St. Agnes – it is very pure, but wher it results from the more rapid operations of the miner, as in the bed an at the mouth of the noted "Red River" which divides the parish o Illogan from Camborne, it is extremely impure from the presence o pyrites, mispickel, wolfram, chalcopyrite, and other more or less readil decomposable minerals. These impurities no doubt existed to som extent in the veins from which all stream-tin appears to have bee derived, but have been removed gradually by natural chemical as well a mechanical processes.

2. As the filling of definite fissures traversing granite, slate ("killas") porphyry ("elvan"), and other rocks; usually in a distinctly crystallin condition. The so-called "leaders" of most of the tin lodes of th county are such deposits.

The fissure-deposits properly so-called have been well described b Henwood, Foster, and others.†

3. As the filling of minor joints, fissures, and shrinkage cracks in such rocks, also generally in a crystalline condition. Minute fissures so filled are observable in almost all sections of tin-stones. When such tin-filled joints are numerous, we have the so-called "stockworks" of the county.§

The stockwork deposits are less known than the fissure deposits proper, but they occur in many localities both in granite and killas. Fig. 1, pl. 1 represents a fragment of killas from such a deposit at Minear Downs, near St. Austell.

4. As the cementing material of conglomerates and breccias

* "Observations on the detrital tin-ore of Cornwall." *Journ. Roy. Inst. Corn.*, No. xi., 1874.

† See *Trans. Roy. Geol. Soc. Corn.* Especially Vols. v., viii., and ix.

§ Some of these stockworks are described by Dr. C. Le Neve Foster in the *Quart Jour. Geol. Soc.*, Aug. 1878, p. 654.

occupying fissures. Such deposits have been observed at Wheal Fortune, near Marazion; Perran Downs, near St. Hilary; Relistian in Gwinear; and more recently on what is believed to be the same lode as this latter at New Rosewarne Mine in the same parish.

At Relistian rounded pebbles of a dark green chloritic schist several inches across occurred, cemented together by a mixture of oxide of tin, chalcopyrite, and quartz sometimes amorphous, but usually more or less crystallized. A fine specimen of this conglomerate, now in the Museum of the Royal Institution of Cornwall, is represented in fig. 2, pl. 1.

At New Rosewarne Mine Dr. Foster * distinguishes six periods in the formation of the deposit as follows:—

I. Formation of an open crack or fissure into which fragments of the walls fell, and a few pebbles from above.

II. These fragments were cemented together forming a killas-breccia.

III. The crack re-opened; fragments of the already formed breccia fell in from the walls, together with very great quantities of killas and a number of rounded pebbles.

IV. This confused mass of fragments was cemented into a solid mass by having quartz, tin-stone, mispickel, and chlorite deposited around the pieces.

V. Crack re-opened on the south side.

VI. Copper ore was deposited and sent small veins into the already existing tin lode.

Dr. Foster considers that the cementing materials were introduced in the following order or nearly so.

1. Quartz
2. Tinstone
3. Mispickel
4. Chlorite
5. Pearl-spar, calc-spar, chalcedony, iron pyrites and copper ore.

5. As a constituent of ancient breccias occupying fissures, as at Prideaux Wood Mine.

6. As a minor constituent of granite, elvan, schorl-rock, tourmaline-schist, and "capel," mostly in tolerably distinct crystals.

* *Report Miner's Assoc. of Cornwall and Devon*, 1866, p. 26.

The remarkably rich deposits at East Wheal Lovell * and Rock Hill, † the celebrated "Carbonas" of the St. Ives district.‡ and the numerous apparently isolated nests of tin crystals met with in decomposed granite may be mentioned in this connexion.

7. As pseudomorphic replacements of felspar, schorl, quartz, and occasionally other minerals—in granite, elvan, or capel.

Many of these have been observed at Rock Hill,‖ Belowda Hill,§ and numerous other localities, the crystals being replaced sometimes by cassiterite alone, sometimes by a mixture of cassiterite and schorl.

8. As a pseudomorphic replacement of organic structures.

Fragments of deer's horns impregnated with oxide of tin from the Carnon Valley are now in the Museum of the Royal Geological Society of Cornwall, at Penzance, in the British Museum, and in a private collection at Lostwithiel. These horns will be further referred to hereafter.

Setting aside the stream-tin, which is of course derived from the degradation of pre-existent rocks, the fissure and joint deposits (2 to 5) and the pseudomorphic replacements (7 and 8) are evidently due to stanniferous solutions, and few will doubt that the tin which occurs as a minor rock-constituent (6) is also due to the passage of such solutions through the rock. On this point more will be said hereafter.

The "capel" above referred to is simply an altered band of country, whether granite or slate, occurring in the immediate neighbourhood of most of the fissures which contain oxide of tin. So long as it contains enough tin to pay for working it is regarded as part of the lode by the miners, when it ceases to contain tin or contains so little that it will not pay to work, it is called capel and regarded as "country." It is therefore impossible to separate tin ore from tin capel in any scientific sense.

The workable capel is often many times wider than the original fissure or lode proper. Fine examples of these tin-bearing capels occur at Dolcoath, Tincroft, and other mines near Camborne.¶

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* Foster, *Trans. Roy. Geol. Soc. Corn.* ix. p. 167.

† Collins. "Notes on the Rocks and Goonbarrow Mines." *Rep. Miner's Assoc. of Cornwall and Devon*, 1873, p. 66.

‡ Henwood. *Trans. Roy. Geol. Soc. Corn.*. Vol. v.

‖ Collins, "Notes on the Rocks and Goonbarrow Mines" cited above.

§ Foster, "Notes on Belowda Hill Mine," *Journ. Roy. Inst. Corn.*, xvii., 213.

¶ In a recent paper read to the Geological Society of London, our Foreign Secretary Dr. C. Le Neve Foster has described in considerable detail one of the most important lodes in Cornwall, the so-called "flat-lode" which lies on the south side of Carn Brea Hill, near Redruth. This lode has been worked to a great depth in a series of adjoining mines, and for a length of several miles. For a part of that distance it occurs between the granite and killas, but in some places it is bounded by granite, and in others by killas on both sides; the lode although variable in direction (bearing) and slope

Three distinct modifications of Cassiterite have long been known, and of each there are several varieties which have received distinct names. The three kinds are—

a. Crystallized (Diamond Tin, Sparable Tin, Rosin Tin.)

b. Fibrous and Radiated (Wood Tin, Toad's Eye Tin, Shot Tin.)

c. Pseudomorphous (after felspar, quartz, schorl.)

All three kinds occur in stream-tin, and in well known subterranean deposits.

The crystallization of Cassiterite was long ago worked out with great minuteness by Wm. Phillips, in a memoir presented to the Geological Society and illustrated by no fewer than 235 figures of crystals. Mr. Phillips calls attention to a very important fact which is still as suggestive and almost as puzzling as it was in his time, viz., that certain combinations of forms are characteristic of certain deposits, remarking that "entire veins seem to be productive principally of the same varieties; of this fact he gives several remarkable and striking examples."*

I would also mention an elaborate memoir on the crystallization of Cassiterite, by F. Becke, which appeared in 1877, in Tschermak's Mittheilungen, † in which the author endeavours to shew that three

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(underlie) being more nearly in a plane than the actual junction of the two rocks. The actual fissure appears everywhere to have been small, rarely more than two feet wide and often only a few inches—or even a mere joint. The fissure must have been actually open for some time as it is more or less completely filled with a sort of breccia, formed of pieces of the containing rocks cemented together by quartz, oxide of iron, oxide of tin and other minerals. The country is highly silicified, sometimes on one side, but often on both sides of the fissure or lode proper, and thereby converted into what the miners term capel. In some parts, especially near the fissure proper—the capel contains enough tin to pay for working, when it is regarded by the miners as part of the lode and worked as such.

The capel, whether originally granite or killas has now pretty much the same appearance—indeed the only observable difference usually is that the altered killas retains some of its original lamination, while the altered granite has no such lamination. [See fig. 5 pl. iv. Tresavean, and fig. 3, pl. ii. Penhalls.

The following figures from Dr. Foster's paper will shew the importance of this lod from a miner's point of view.

	Tin Stuff. Tons.	Clean Tin Ore. Tons.
Wheal Uny, in 1876 produced ...	17702	349
South Carn Brea	2040	30
West Basset	29144	618
West Wheal Frances	6652	123
South Condurrow	19421	588
Wheal Grenville	8500	138
Total	83459	1846

The average produce was 2¼ per cent. of clean tin ore (black tin). The above was more than one-eighth of the total production of tin ore in Cornwall, in 1876. (See further, Foster on the Great Flat Lode, Quart. Journ. Geol. Soc., Aug. 1878.)

* *Trans. Geol. Soc.* Vol. 2.

† *Min. Mitt.* 1877, p. 244.

distinct types of form-combination characterise the crystals of Saxony and Bohemia, Cornwall, and Pitkaranda respectively. The author does not, however appear to have seen the elaborate memoir of W. Phillips referred to above.

Crystallized Tin proper is always more or less transparent, thin splinters invariably allowing a large proportion of light to pass. It is occasionally nearly colourless, but generally exhibits various shades of brown, from brownish-yellow to nearly black. Under the microscope in thin sections it always exhibits a peculiar granular appearance somewhat like that observable in olivine. The purest crystals are dark with polarized light and crossed prisms, but generally even well-formed crystals exhibit bright sparkling granules due to minute particles of entangled quartz.*

Cassiterite is distinctly dichroic, but usually very slightly so.†

Large crystals are occasionally found lying loose in the vein as in the case of the fine macles formerly found at Seal-Hole Mine, and the unique curved crystals found at Wheal Fanny; both figured by Phillips in the before-mentioned memoir.

A variety which occurred in the lode at St. Austell Consols a few years since, at a depth of 15 fathoms below the adit, consisted of a mass of amorphous cassiterite covered thickly with minute acicular crystals, the latter evidently a secondary formation.

Wood Tin. This is so called because of the resemblance of its fibrous-radiated structure to that of exogenous wood; it was long supposed to be peculiar to the stanniferous gravels (stream tin), but its occurrence in the lode at Wheal Providence, near St. Columb, in masses of about a pound weight, near the beginning of the present century, was reported to the Royal Geological Society of Cornwall, by Mr. Ashurst Majendie, in the year 1818,‡ since then it has been found at Polberrow Consols, Blue Hills,

* Analyses of crystals of Cassiterite almost invariably reveal the presence of small proportions of silica.

† "The optical properties of tin-stone do not appear to have been investigated since Brewster's time; at least Des Cloizeaux who places tin-stone among the uniaxial and positive substances refers to Brewster (*Ann. des Mines*, 1857, p. 300), as his authority. For investigating the optical properties, a section was used cut at right angles to the principal axis of one of the individuals of a twin crystal from Schlackenwald, whose intercalated twinned lamellæ also permitted an investigation as to dichroism. In the polarizing microscope by white light a dark washed-out cross was seen, without, however any indication of coloured rings, although the plate (or slice) was 1*mm* thick. By using a plate of biaxial mica the cross was resolved into two hyperbolas, the major axes of which were at right angles to the principal optical section of the mica plate.

The twin-lamellæ, which as might be expected (selbstverstandlich), shewed no cross in the polarizing microscope, were examined with Haidinger's dichroiscope and appeared very slightly dichroic. The two images shewed a difference of tint in the brown which was scarcely observable,—one was dark brown with a touch of reddish-brown, the other was slightly duller with a somewhat greenish sheen." F. Becke, in Tschermak's *Min. Mitt.*, 1877.

‡ Trans. Roy. Geol. Soc. Cornwall, Vol. 1, p. 237.

Penhalls, Wheal Coates, Wheal Coit, and Wheal Trevaunance, all in the parish of St. Agnes; at several mines in Gwinear and Sancreed parishes; and notably in the 162 fathom level at Wheal Vor, in the year 1866.* At this latter mine it occurred in large kidney-shaped masses, associated with crystallized cassiterite and quartz in a part of the Wheal Metal lode six feet wide and worth fully £600 per fathom. The wood-tin occurred mixed up with ordinary crystallized tin-stone together with much chlorite, chalcedony, dolomite, felspar, and pyrites.

A very remarkable occurrence of Wood Tin was met with at Prideaux Wood Mine, many years since in a kind of conglomerate of grains and crystals of quartz cemented together by yellow copper ore and oxide of iron. In this complex mass were embedded fractured segments of globular concretions of wood tin originally from one inch to four inches diameter. These shew a well-marked concentric and radiated structure, the former being indicated by bands of alternate dark and light brown tint. Altogether they much resemble the kind of concretionite known as "wood iron." Fine specimens of this conglomerate may be seen in the British Museum.

At the Garth Mine (since known as East Wheal Cock) about two miles west of Penzance, about the year 1827, wood-tin in botryoidal masses and toads-eye tin occurred in great quantity—together with ordinary crystallized tin-stone, quartz, felspar, chlorite and carbonate of iron.†

Wood Tin is so nearly opaque, even when of light colour; and at the same time so brittle that it is extremely difficult to get it transparent enough for examination beneath the microscope. One of its most common modes of occurrence is as a thin opaque fibrous coating on the summits of quartz crystals. ‡ A section of this kind of formation sometimes exhibits a zigzag arrangement of lines somewhat resembling "fortification agate," and might be called "fortification tin." Other forms of Wood Tin are known as "toad's-eye" tin, "pea-tin," and "shot-tin." These consist of small brown spherical masses, in the first case imbedded in quartz or other material of a lighter hue than the oxide itself; and in the second aggregated together with little or no foreign intervening material. F. Becke regards Wood Tin as an extreme form of the well known acicular crystals sometimes spoken of as "Needle Tin." There are however, some rather important physical differences.

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* G. M. Henty, Rep. Mincrs. Association of Cornwall and Devon, 1867, p. 55.

† Carne, *Trans. Roy. Geol. Soc., Corn.* Vol. iv. pp. 99-100.

‡ Occasionally these coatings form a kind of cap which may be lifted off at pleasure.

Pseudomorphous Tin Ore. This occurs at many localities in Cornwall replacing Orthoclase, Quartz, Schorl, (?) Wood, (?) and Horn.

"Large pseudomorphous crystals of cassiterite after felspar occurred formerly in considerable abundance at Huel Coates, St. Agnes. . . . Many of the larger crystals presented the curious circumstance of shewing the original felspar replaced by oxide of tin only about half across longitudinally. Similar pseudomorphs have been found at Carn Brecon, St. Mewan, near St. Austell; and also, about ten years ago at Balleswidden, St. Just, by Mr. Rd. Pearce.

The silicate of tin described by Mr. G. Garby is perhaps a pseudomorph after quartz. Some occurred about 1820 (at Wheal Primrose) as an impalpable powder, or compact; yellowish-grey in colour and composed of 53·0 p.c. of oxide of tin, and 46 per cent. of silica. According to Mr. J. Michell, some of the silicate of tin was in hexagonal prisms, much like quartz, but with the summits always wanting."* The writer has one of these prisms in his collection which will be further referred to hereafter.

I have lately been studying the microscopic characters of a considerable number of Cornish tin-stones, and I now propose to bring the results before the Mineralogical Society.

Crystallized Tin-Stones.

a. Tin in Elvan.

Tin Ore from Budnick Mine, St. Agnes. This is a compact dark greyish-brown material occurring in irregular veins in a light grey elvan, and also as the cementing substance of brecciated portions of the same elvan; the elvan traverses killas. Under the microscope with half-inch objective, ($\times\frac{66}{1}$,) it appears as in fig. 4, Plate II, and is seen to be composed of cassiterite, quartz, and a fibrous green chloritic mineral. The cassiterite consists generally of well defined yellowish to brownish crystals, often very simple in form, many of them shewing distinct "lines of growth" marked by layers of a darker brown tint, and all possessing the peculiar granular appearance already mentioned as characteristic of cassiterite. A few of the crystals are black with crossed prisms, but most of them are brightly coloured from the presence of minute granules of quartz.

The interspaces between the crystals are mostly filled with quartz, more or less powdered with a greyish to black dusty material, a few fine needles of schorl, and many minute fluid cavities. In places, however, there are patches of the green chloritic mineral, partly fibrous and radiating, partly distinctly crystallized in the form of felspar, of which mineral they are I believe pseudomorphs. This green material is scarcely if at all dichroic. I regard it as one stage in the transformation of felspar into acicular tourmaline.

* Collins, *Handbook to the Mineralogy of Cornwall and Devon*, part ii. p. 25.

Belowda Hill. This also is an elvan deposit, the tin occurring in nests and veins. The specimens examined show a great deal of tourmaline in large radiated masses. Many of these exhibit bright blue and green tints, with ordinary (unpolarized) light. There are also numerous fine colourless or very pale blue needles of the same mineral, and some radiated groups of a colourless or pale-greenish yellow, flaky or semi-fibrous mineral, which is no doubt Gilbertite.

Two felspars are discoverable, one however being mostly changed into Gilbertite, while the other occurs in moderately large, much-fissured, and only slightly changed crystals.

The cassiterite is mostly present in highly modified "massular"* crystals, but it presents nothing special in its optical characters. A portion of one of the slides is represented in fig. 3, pl. iii, under the one inch power ($\times\frac{28}{1}$)

Parbola. The specimens examined were cut from a dark vein traversing a gray elvan. The sections shew a mass of large crystals of cassiterite closely compacted together. Many of these enclose long slender needles of what appears to be tourmaline, and the few interspaces are filled with a dark brown ferruginous substance. The whole is much fissured, and stained reddish-brown in the neighbourhood of the fissures.

New Rosewarne. In this also the tin occurs as dark veins in a light-coloured elvan. With the one-inch power, the veins are seen to be composed of needles and brush-like groups of tourmaline mingled with large macled crystals of cassiterite.

Tresowes. The specimens examined were cut from a large pebble of "stream tin," found at Tresowes clay works, in Breage. It consists of a mass of large macled "massular" crystals, shewing distinct "lines of growth,"—not unlike the Budnick crystals, but larger and less simple in form. They were probably derived from a vein traversing elvan at Tregoning Hill, on the side of which Tresowes is situated.

Terras, (St. Stephens). This elvan has been rather extensively worked for tin. It is a grayish stone with numerous dark-brown and nearly black patches, which are evidently pseudomorphous fillings of cavities from which felspar has been removed. Most of these are filled with interlacing crystals, or amorphous grains of schorl—some contain both

*Lat. *Massula*,—a little lump. A word seems to be required to denote crystals which are approximately of equal dimensions in all directions. *Massular* will then be analogous to *acicular* and *tabular* as under.

Massular, pretty equal in dimensions.
Acicular, much extended in one direction.
Tabular, much extended in two directions.

"Acicular" crystals are called Prismatic, when the needles are tolerably thick.

schorl and cassiterite, and a few are wholly filled with crystals and crystalline grains of this latter mineral, mostly "massular".

A piece of this elvan is represented in fig. 3, pl. XI.

A great many other elvans have yielded tin ore in quantity from time to time in Cornwall, as at Castle-an-Dinas, Wheal Jennings,* &c. In all these the cassiterite either occurs as the filling of fissures and veins, or as a replacement of felspar, and always more or less associated with schorl.

At Wheal Jennings sometimes as many as 30 separate "strings" could be counted in the space of one inch.

b. Tin in Granite.

East Wheal Lovell. The slides prepared and examined were from the remarkable tin deposit described by our foreign secretary, Dr. C Le Neve Foster.† Originally a granite, much of the felspar is changed to a gray, dusty looking material, not dark with crossed prisms, which with a high power ($\times\frac{225}{1}$), seems to consist of minute and imperfectly-formed crystals of Gilbertite, and perhaps a little tourmaline. In places in the neighbourhood of these grayish spots there are very distinct needles of tourmaline, and radiated flakes of Gilbertite. The quartz contains many fluid cavities, and includes a little black opaque mica, together with some irregular crystals and granules of cassiterite, which are of a somewhat darker colour than usual.

Balmynheer. This also is from partially decomposed (kaolinized) granite. It has a basis of quartz which encloses and surrounds bands and nests of small irregular crystals and grains of cassiterite, mingled with minute crystals, grains, and feathery groups of blue and brown tourmaline. Using the half-inch power ($\times\frac{90}{1}$), the quartz appears powdered with grayish dust, but with the one-fifth ($\times\frac{225}{1}$), most of this is resolved into minute needles of tourmaline.

Fleddry (near Bugle, St. Austell). The specimens examined were from a great stanniferous band of only slightly altered granite, which crosses the decomposed granite (Caclazyte or china clay) of the neighbourhood. At Rocks and Great Rocks Mines this is known as the Fleddry lode. The stone is grey in colour, and has a granitic appearance. Under the microscope it is seen to consist chiefly of quartz, having a dusty appearance from the presence of innumerable minute cavities; mingled

* See an excellent description of the mode of occurrence of the cassiterite at Wheal Jennings, from the pen of Mr. Geo. Seymour, Jun. *Trans. Roy. Geol. Soc. Cornwall* IX, 185.

† *Trans. Roy. Geol. Soc., Cornwall*, Vol. IX, p. 167.

th the quartz, are a little Gilbertite, many dark patches of tourmaline nged with bluish needles of the same mineral, a few bright yellow and ıe patches of tourmaline, and certain dark-gray granular looking masses hich appear to replace felspar crystals; with the half-inch power, these ter are seen to be composed of little crystals of cassiterite—mostly tangular, or nearly so in section. An average sample of the stone ken from the band—which is about 20 ft. wide, and contains very little visible to the naked eye—yielded, on analysis, 3½ per cent. of metal-tin.

Wheal Bunny, St. Austell. This is very similar to the stone from the ddry lode just described, and it occurs in a lode or band which is prob-y continuous with it. The bulk of the stone is quartz, in which are ny beautiful branches and radiating groups of green tourmaline needles sometimes surrounding crystals of a yellow, blue, or brown colour, as a nge. The cassiterite occurs apparently replacing felspar, as in the last mple, but is much brighter in colour, and separate crystals are even aller. No prismatic or acicular crystalsof cassiterite are visible in ner of these instances.

West Basset, flat lode. The specimen illustrated in fig. 2, pl. iv. may be en as a type of the "blue peach" tin-stones of the lodes in the Carn ea district. Occasionally the tin appears somewhat in the form of broken spar crystals—in some instances exhibiting a cleavage-structure and m resembling orthoclase. In the section illustrated the cassiterite appears an irregular band filling a fissure which crosses still older fissures filled h quartz—these latter traversing a matted mass of acicular crystals of rmaline.

Dolcoath, 314 *fathom level.* This stone is very similar to the last. re again the veins of quartz cut through the acicular mass of blue rmaline and are themselves traversed by veins of cassiterite. Fig. 4 iv shews part of one of these veins under the half-inch power, and 3 is intended to illustrate the minute structure of "the blue peach" is under the one-fifth power ($\frac{225}{1}$). In the fissures there is much acicular rl. Some of the tin veins are in places as little as $\frac{1}{500}$th of an inch in kness. Separate grains and crystals are sometimes only $\frac{1}{1000}$th of an n.

Dolcoath. 324 *fathoms level.* Blue peach tin-stone. This is very similar he stone just described.

Dolcoath. Sump below the 314 *fathoms level,* 1878. This stone is lently a breccia, it consists of angular patches of a fine-grained green or sh material, which is apparently composed in the main of a net-work fine needles, imbedded in a crystalline mass of cassiterite, which

exhibits distinct crystals in a few places. A little quartz occupies t interspaces, which are very few—and this encloses many fine needles tourmaline.

Dolcoath. Very rich stone from about the 260 *fathoms level.* 60 *p. metallic tin.* This is a mass of rather large grey crystals—most massular, some have a yellowish or brownish centre—there are al frequent yellow stains near the lines of cleavage. Some of the cryst shew very numerous cleavages—mostly however parallel to the princip axis of the crystals. "Lines of growth" are scarcely to be seen in eith of my sections (5) of tinstones from this part of the mine. With t cassiterite in all the sections is a little quartz and some fringed crystals tourmaline. Some of the crystals contain imbedded needles which a probably schorl.

East Caradon, stone raised in 1866. This is a very beautiful sto consisting chiefly of large and rather simple prisms of cassiter intermingled with a little quartz and some beautiful dark gre hexagonal crystals of a mineral which appears to be tourmaline. F 2, pl. V. represents a portion of one of the slides as seen with t $2\frac{1}{2}$ in. objective ($\times\frac{12}{1}$.)

North Treskerby. This consists of a dark reddish-brown stone, sectio of which under the microscope sre seen to consist of light-coloured crysta mostly prisms, embedded in a deep red, nearly opaque substance, whic is mainly, if not exclusively oxide of iron. A few of the prisms are stain with red in spots and patches. The appearance presented when viewe with the one-inch power($\times\frac{28}{1}$) is as shewn in fig. 4, pl. V.

c. Tin in Schorl-rock.

Boscaswell. This is a schorl rock "tinstone," it consists almost entirel of highly modified "massular" crystals of cassiterite mingled with schor and forming a firmly compacted mass. It contains, however, many smal cavities or "vughs," and these are generally crossed by slender needles of tourmaline as shewn in fig. 5, pl. ii. One slide in my possession has a little striped felspar shewing between the cassiterite crystals; a few minute red garnets are also visible.

Boscaswell Downs. This very beautiful tin-stone is also from schorl rock. It consists of a basis of clear quartz, in which are enclosed many large brilliantly coloured tourmaline crystals, with fringed edges like those described as occurring in the black quartz crystals of Boscaswell Downs.* There are also numerous fine separate needles or small groups of needles of the same mineral sprinkled through the quartz. The quartz basis also encloses some rather large "massular" macles and irregular grains of cassiterite.

* See "On certain Black Quartz Crystals," by J. H. Collins, *Min. Mag.*, Vol. I, p. 115.

Rock Hill. This stone is from the remarkable mass of stanniferous rl rock described by me in the Mineralogical Magazine, in 1876.* ome parts the rock is composed largely of quartz, in others it chiefly ists of schorl, but everywhere there is a little tin. Fig. 1, pl. iv. esents a thin section of a dark bluish mass from this deposit, under half-inch power ($\times\frac{66}{1}$). When thus examined it is seen to be composed he main of an agglomerated net-work of very fine acicular crystals blue tourmaline, in which are imbedded radiated groups of much er crystals of brown tourmaline, and a few small crystals of cas- rite exhibiting the characteristic granular appearance.

d. Tin in Killas.

Wheal Vor, 160 *fathom level.* This is a killas "tin-stone," it is, how-, very similar to the Budnick specimen, but the crystals of cassiterite less distinctly prismatic, generally somewhat more highly modified, uently fractured, and often macled. Fig. 1, pl. iii. shews one of these les drawn with the camera lucida under the half-inch power ($\times\frac{66}{1}$).

he quartz of this stone contains many minute fluid cavities and a n fibrous chloritic mineral, similar to that occurring in the Budnick imens.

Tretoil. This is also a killas tin-stone. It consists of a *melange* of tals of cassiterite, mostly short prisms, with a very little of a dark rstitial mineral—probably oxide of iron—and a few cavities which n to have been originally felspar crystals, but are now occupied by mi-fibrous greenish, grayish, or yellowish mineral. Fig. 4, pl. V, esents part of a slide of this stone as seen with the one-inch ctive.

With polarized light these crystals shew brighter colours than l. No quartz is visible in the stone.

art of the specimen was analysed and yielded 92 p.c. of oxide of tin.

Wheal Vor, 140 *fathom level.* This is a specimen of a kind of ore h was worked very largely at Wheal Vor, a few years since. It con- of alternate bands of dark grey slate, and of quartz filled with tals of cassiterite. Fig. 2, pl. iii. represents part of a thin section nified, shewing the dark slaty bands alternating with the lighter ls of quartz, and these latter interlaminated with oxide of tin, some- s in irregular forms, but mostly in crystals more or less highly ified. Fig. 4, pl. iii, represents a part of the same section more ly magnified ($\frac{150}{1}$.). The quartz seems to have crystallized between

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*On the occurrence of Achroite at Rock Hill. *Min. Mag.*, Vol. I., p. 55

the laminæ of the slate so as to extend them, and the tin oxide has th
been deposited in its cracks and cavities.

With the one-fifth objective ($\times\frac{225}{1}$), many fine needles of tourmali
are visible, which seem to lie mostly with their long axes in t
directions of the laminæ, and to follow them in their bends arou
certain dark shapeless opaque knots, which are probably amorph
tourmaline. An attempt to represent this appearance is made in f
5, pl. iii.

New Fowey. These specimens are from a lode traversing killas a
situated a little to the north of the great Fowey Consols lodes; it
only been worked a few fathoms deep. In this specimen with t
quarter-inch power ($\times\frac{150}{1}$), the cassiterite is seen to consist of sm
highly-modified crystals mingled with chlorite, some of which occurs
beautiful rams-horn groups; the whole imbedded in a basis of quart
shewn in fig. 2, pl. ii.

Part of this specimen was analysed and yielded 22 p.c. of oxide of

Penhalls. The specimens examined consisted of a dark grey
siliceous killas. Under the microscope the appearance did not mat
ally differ from the Penhalls capel, hereafter to be described, exc
that there were veins and patches of tin visible.

Penhalls "Toad's eye" Tin. Much of the toad's eye tin observed
different mines—as at the Garth Mine near Penzance, consists of wo
tin, and will be described in a future paper. Much wood-tin occ
too at Penhalls Mine, but the specimen of "toads eye" examined fr
here, which was kindly furnished by Dr. Le Neve Foster, consi
chiefly of ordinary crystallized tin, arranged in a somewhat peculi
manner.

To the unaided eye the specimen presents the appearance repr
sented in the fig. 1, pl. V. A thin cross-section under the two in
power ($\times\frac{15}{1}$) shows a group of cross-sections of rectangular prisms, in
bedded in and surrounded by quartz. This group is surrounded at
little distance by an incomplete circle of crystals having a slight
radiating structure, and exhibiting nearly concentric lines of growth
shewn in fig. 3, pl. V. A few angular dark patches which also have
somewhat circular arrangement are apparently interspaces betwe
quartz crystals; some of them are seen to contain many minute needl
of tourmaline when viewed with high powers. Others look like ver
dark wood tin.

The whole arrangement looks as if it had arisen as follows:—

a. Formation of bundles of prisms of cassiterite in a quartz magm

b. Deposition of quartz in more or less distinct prisms around the centres so formed.

c. Deposition of cassiterite and tourmaline irregularly on the outside of the quartz groups, part only being crystallized.

d. Deposition of quartz around the whole compound mass.

Wheal Fortune, Breage. The specimen examined consisted of a dark greyish-brown killas spotted and banded with white quartz, and having light yellowish-gray macled crystals of cassiterite in its joints varying from $\frac{1}{4}$th to $\frac{1}{12}$th of an inch across, and mingled with a little wilbertite.

Thin sections of the killas near the joints were made, and in these the quartz was seen to be as usual full of minute cavities, giving it a gray dusty appearance. It also contained very large numbers of tourmaline needles, blue near the tin crystals of the joint, but elsewhere brown, and arranged in a somewhat banded manner, the joints cutting the bands nearly at right angles. The whole may be regarded as a stanniferous tourmaline-schist.

Roche Consols. This also is a highly stanniferous tourmaline-schist, the basis of which is mainly cassiterite instead of quartz as is usual. It is much more stanniferous than the last as the tin seems to permeate the whole rock, instead of being mainly confined to the joints.

Wheal Primrose, St. Agnes. The specimen from which my sections were cut was an old one, the mine having been closed for many years. It is a compact grayish stone to the naked eye, not unlike a stanniferous sandstone. In a thin section it is seen to consist of a mass of light-colored quartz full of minute needles of dark-brown cassiterite, often pointed at each end. A good many brown patches and grains of oxide of iron are visible, and also some patches of what looks like tourmaline

e. Tin Breccias

Reference has already been made to the occurrence of cassiterite in the material filling fissures, &c., in various kinds of rock. The specimens now to be described probably differ nothing in principle from these, but being on a much larger scale, it may be convenient to place them here under a separate heading.

Relistian and New Rosewarne. The tin conglomerates of these mines have already been described (page 3).

Wheal Lucy. This mine was worked a few years since to a very moderate depth. The tin deposits were very irregular, much of the tinstone consisted of a breccia composed of a peculiar soft brownish material, which looked like decomposed greenstone, cemented together

with cassiterite, often in large crystals, and a little quartz. A specimen of this breccia is represented in fig. 3, pl. i, drawn to the natural size.

In thin sections under the microscope some of the included fragments exhibit a structure which might very well belong to a basaltic rock which had undergone much decomposition.

Wheal Uny. Compact Tin-stone. This is a very peculiar tin-stone. Viewed in the mass it looks like an alternation of bands of dark "blue-peach," and of a paler grayish-brown material, both extremely fine-grained and very hard. Under the microscope, in thin slices. it looks like a breccia, in which ordinary "blue-peach" plays the part of the cementing material, and encloses angular fragments of a peculiar brownish-gray granular material, which certainly contains tin, from the known richness of the stone, but is optically quite unlike ordinary crystallized cassiterite. The whole mass has been fissured across, and the fissures filled up subsequently with quartz,and, in one specimen, some very light coloured crystals of cassiterite of the ordinary kind. In the neighbourhood of this there are distinct needles of schorl; elsewhere these are almost entirely absent, the blue-peach being mostly made up of the greenish or bluish chloritic material.

Needles of the tourmaline project into some of the quartz masses, and these latter as well as the quartz of the veins are full of minute fluid cavities.

TIN CAPELS.

As already stated, there is no real geological or petrological distinction between *tin-stones* and *tin-capels*—a capel being merely a tin-stone which does not contain enough tin to pay for working. As the average produce of the Cornish tin-stones is but little over 2 per cent. of tin-oxide, and as many are worked with less than 1 per cent., it will be seen that the distinction made by practical men rests entirely upon considerations of economical working, which vary with the locality and the surrounding conditions. Thus the 'capel' of one mine may be the 'tin-stone' of another.

To the unaided eye capels appear in three principal forms, which may be termed *granitic*, *schistose*, and *compact* respectively. The latter is essentially a deposit of amorphous or crypto-crystalline quartz, which may or may not enclose particles of foreign bodies; it is not usually of much importance, nor does it occur to any very great extent in connexion with the Cornish tin ores.

The granitic and schistose capels on the contrary are of the highest importance, and are usually readily enough distinguishable from each other, although they no doubt pass into each other at times. Both are very highly altered rocks, which have been altered by precisely the same chemical agencies. Both are characterised in general by the presence of much tourmaline in some form or other, and the types of their extreme modifications are 'schorl-rock' or 'schorlyte,' and 'tourmaline-schist.' Each consists essentially of quartz and tourmaline, in the first arranged irregularly as in granite, in the second in approximately parallel bands, due no doubt to the original lamination of the schist from which it has been derived. Occasionally both may be seen in one stone as in the specimen from Wheal Burn, illustrated in Plate VI.

Both these important rocks are found in great abundance near the junctions of granite and killas—and I believe nowhere else; rarely indeed are they found more than a mile from the actual junction except of course as surface or subsoil fragments, or as transported materials in valley gravels, and occasionally in so-called raised beaches.*

a. Granitic Capels.

South Condurrow, flat lode, "grey back," or "black-granite." In mass this is very dark bluish gray, evidently an altered granite, the felspar changed to quartz, and the mica to the mixture of chloritic mineral and tourmaline already so often referred to. There are many tourmaline needles in the fissures, and a few irregular grains of tin—some not more than $\frac{1}{2000}$th of an inch across. With the one-fifth objective and a good light, many little yellow grains appear, which may perhaps be tin. Some of these are scarcely more than $\frac{1}{20000}$th of an inch across.

Tresavean. This is a good example of the "blue peach" slightly stanniferous capels, its shadowy granitic structure is shewn in fig. 5, pl. iv. under the half-inch power ($\frac{60}{1}$). Some of the patches of quartz have much the form of felspar crystals, and I believe they were once felspar.

* The quartz of veinstones is usually more or less crystalline, contains numerous gas and fluid cavities, and encloses ores of tin, copper, zinc, and other metals. Capels are most frequently composed of a quartzose base through which crystals of schorl are very thickly disseminated, either in the form of spheroidal aggregations radiating from various centres or as acicular crystals crossing one another in all directions. Sometimes, particularly when they occur in slates, capels are mixtures of quartz and chlorite; in others both chlorite and tourmaline are present. They also often contain innumerable small fragments of the country rock, and are traversed by narrow strings of quartz into which project hair-like crystals of schorl, which are generally attached to the sides of the enclosing fissure. Phillips, *Quart. Journ. Geol. Soc.*, Aug. 1875, p. 341.

West Basset flat lode, 114 fathom level. This is a good deal like th Tresavean stone; the "blue-peach" basis is mostly, however, grayis when viewed with a high power, and it seems to consist chiefly of flaky mineral penetrated in all directions with minute needles of blu tourmaline. A few pale green patches are present, which are perhap chlorite. No tin is visible in this stone, except perhaps in patches, i one little vein less than $\frac{1}{500}$th of an inch in thickness, which small as i is, is in one place distinctly "heaved" at an oblique angle by a stil finer one not more than one-tenth its breadth. The brown patches look somewhat like wood tin, and are distinctly fibrous under high powers they are however still more like a brown tourmaline.

Another specimen from this locality shews a little tin and a few brown spots, which are probably peroxide of iron.

Carn Brea. This also is a 'blue-peach' capel. Under the microscope it is seen to be composed mainly of quartz, together with patch of the bluish felted material, a few distinct blue and yellow crysta of tourmaline, and a few grains of tin, the whole exhibiting a shadow granitic structure

There can be little doubt that the four specimens last described which are types of at least one half of the tin stones at present worke in Cornwall, represent granite rock altered *en-masse*, the felspar mostly changed to quartz, the mica to chlorite and schorl; the whole muci fissured and filled up at different periods with quartz and cassiterite. The matted mass of "blue peach" frequently encloses irregular angular portions of quartz, the remains of the quartz of the original granite together with other quartz masses of a more regular form, and apparently pseudomorphous after felspar.

b. Schistose Capels.

Penhalls. This is a good example of an altered killas capel—really a variety of tourmaline schist—in which the alteration has not proceeded so far as to obliterate the original laminated structure. Fig. 3, pl. ii. is drawn as seen under the two-inch objective ($\times \frac{16}{1}$). The rock consists mainly of quartz, but is rendered somewhat laminated by a series of fine bands of amorphous tourmaline. It has been fissured and repaired in several directions and at several distinct times. The whole is crossed by a fissure which is mainly filled with quartz, but carries on its walls an irregular band of a green chloritic mineral, resembling that already described as occurring in the specimens from Budnick and Wheal Vor. A small

nest of cassiterite is shewn at one place. With the one-fifth power ($\times \frac{225}{1}$,) as in fig. 1, pl. ii. the green mineral is seen to be chlorite, sometimes in approximately hexagonal crystals, but more usually in irregularly radiated bundles of plates presenting a fibrous appearance and in the form of felspar crystals. In one or two places the rams-horn groups so common in the New Fowey tin-stone may be seen. The fibrous chloritic substance and the amorphous bands of tourmaline appear everywhere to be passing into acicular needles of tourmaline, which seems to be the final product of the cycle of changes.

Wheal Vor. This is a very hard capel, very similar to the last, only the needles of tourmaline are larger. There are a few small crystals and grains which look like cassiterite, but I am not certain about them.

New Consols Mine. The general structure of this capel is like that of Penhalls, but it contains no chloritic mineral. Instead of this there are many opaque patches and grains of a grey mineral, which shines with a greyish metallic lustre when viewed as an opaque object. As the stone contains arsenic, this substance is probably mispickel.

In the fissures there are a good many acicular crystals of tourmaline, but no tin is visible in the sections examined, although the capel yielded a little tin by treatment on a large scale.

Cusgarne Downs (*Tourmaline Schist.*) This is part of one of the striped surface stones from the junction of the granite and killas which are so abundant in most of the tin producing districts of Cornwall. Like the Penhalls specimens it consists of alternate layers or bands of quartz and tourmaline. The tourmaline here is mostly brown, and occurs in short, rather broad prisms, formed around some opaque substance, which has probably supplied the ferruginous constituent of the tourmaline. The quartz encloses many minute prisms and grains of the same mineral, and a few approximately rectangular brown crystals which may be cassiterite. This may be regarded as a typical specimen of the Cornish tourmaline schist. It contains about 150 distinct bands or layers to the inch.

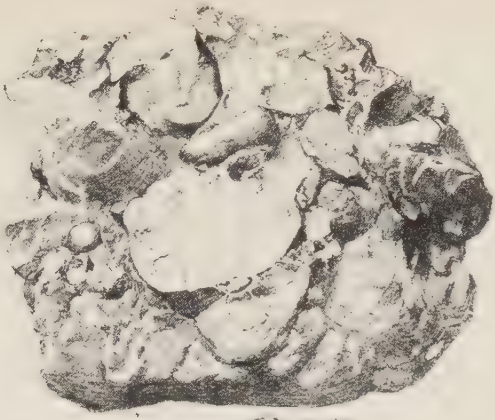
Park of Mines. (Fig. 4, pl. VI.) This is an example of tourmaline schist, from the immediate neighbourhood of one of the richest deposits of tin ever discovered in Cornwall,* but it has many characters in common with the capel just described and also with one of the Wheal Vor stones. As indicated by the figure it is composed of alternate layers of schist, many hundreds to the inch—the dark layers chiefly tourmaline and the

* See "A Deposit of tin in the Park of Mines," by Dr. C. Le Neve Foster.

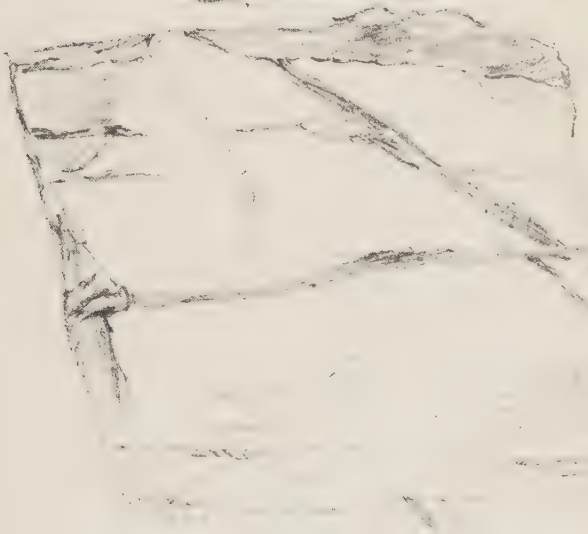
light ones chiefly quartz. Most of the tourmaline here is dark-grey to nearly black and opaque, and in irregular masses, but a few fine needles project into the quartz and here and there a minute grain of tin oxide is discernible.

The foregoing descriptions relate to examples of most of the ordinary tin-stones of Cornwall which contain crystallized cassiterite. In a future paper I propose to deal with the numerous varieties of wood-tin, and to discuss the origin of the Cornish tin-pseudomorphs and tin deposits generally.

STANNIFEROUS CONGLOMERATE.



RELISTIAN MINE.



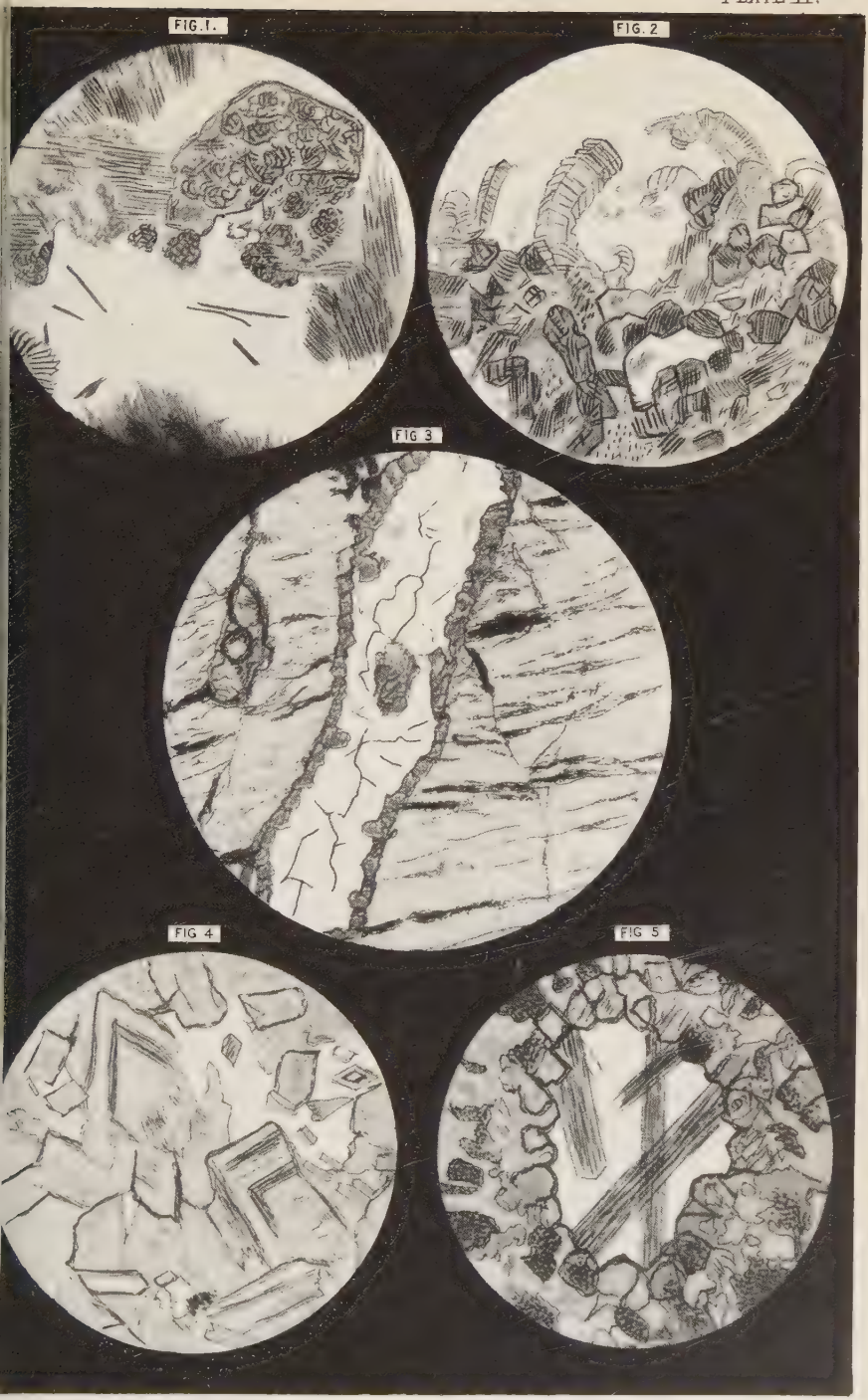
STANNIFEROUS KILLAS.

MINEAR DOWNS.

STANNIFEROUS CONGLOMERATE.

WHEAL LUCY.

J.H.C. Del.



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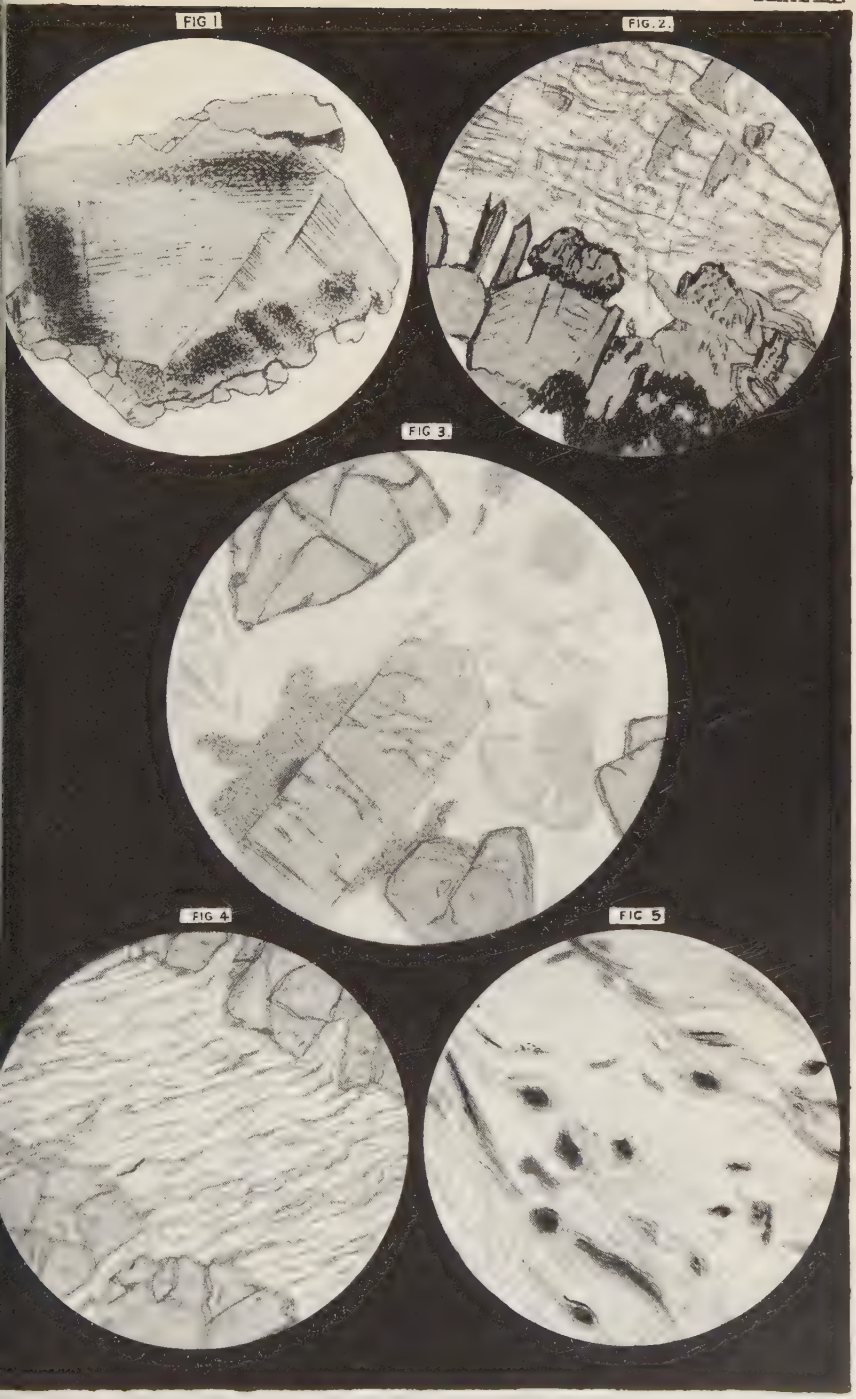

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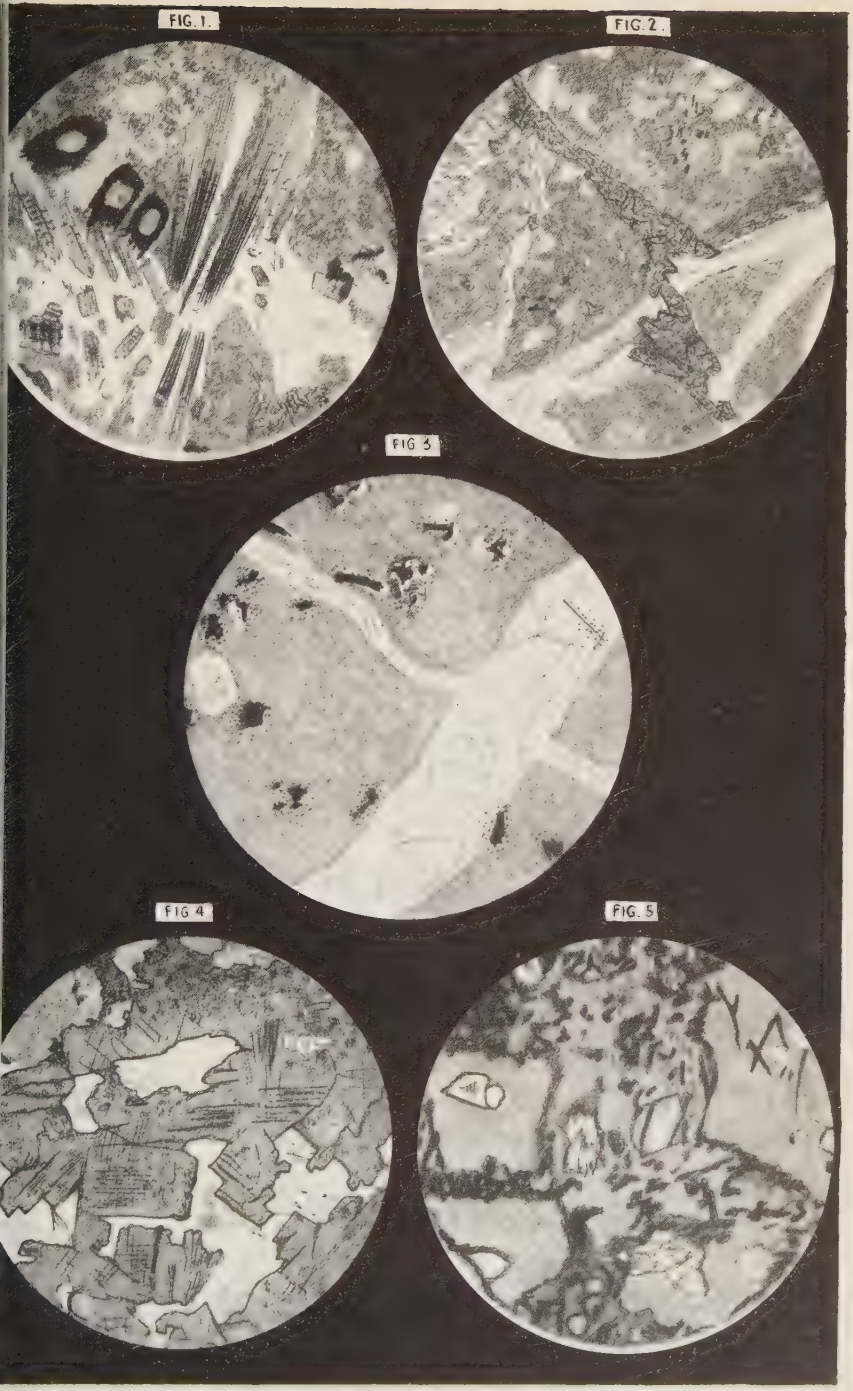

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CORNISH TIN-STONES.

FIG. 1.

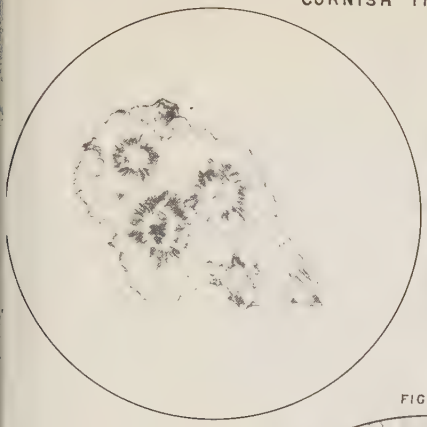


FIG. 2.

FIG. 3.

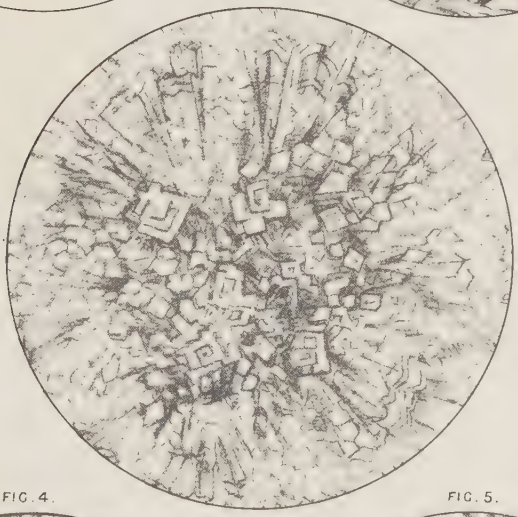


FIG. 4.

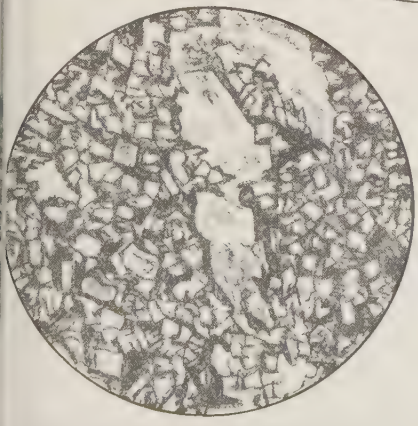
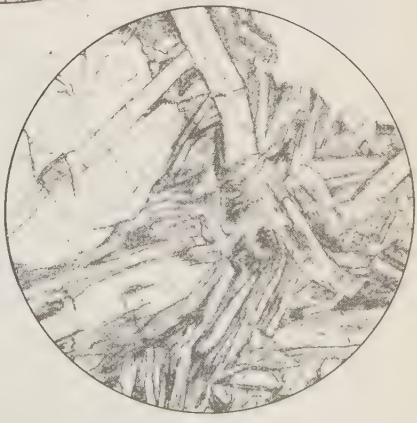
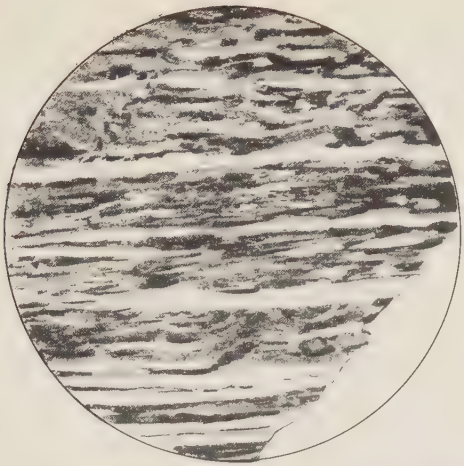


FIG. 5.



CORNISH TIN STONES.



TOURMALINE SCHIST.
PARK OF MINES.

JUNCTION OF
TOURMALINE SCHIST
& SCHORL ROCK.
WHEAL BURN.

H C Del

II.—*The Geognosy and Mineralogy of Scotland.*

By Professor Heddle.

COUNTY OF CAITHNESS.

"A monotony of external configuration affords" says Geikie, "a good indication of the sameness of the geology"; and a country which is devoid of scenic interest, however well it may in a few cases fill the pockets of the metallurgist, will assuredly never satisfy the cravings of the scientific mineralogist.

A land of diverse formations, gashed by rivers, gouged by glaciers, cleft by faults, and hitched about by slips,—with its mountains never of the same mind as regards the fashion of their contours, tossed hither and thither as if they had been kicking about in chaos,—in such a land, he who would learn from the pages of nature may rest assured that he has much to read.

Caithness stands apart from all the counties of Scotland,—pre-eminent in monotony, pre-eminent in ugliness, pre-eminent in dearth of minerals.

A land of flatness,—flags, and fossil-fishes,—the glories of colour and lustre and form are unknown to it: metamorphism, and pseudomorphism and isomorphism, and homœomorphism are words not to be found in its dictionary: it can hardly add one tittle to the records of the past, has no tale to tell of how the old things became new. On its dismal dyke-lined roads the most stalwart walker would grow weary, the hill-man find his occupation gone, for there is little here to climb.

There are some three fairly well shaped hills it is true, but these have huddled themselves in a far off corner in repugnance. Some fairly good cliffs there are, but these, in the singularly rectilinear coasts, impress one with the feeling that they have turned their faces from the land in shame.

An Old Red Sandstone country, which has concentrated all the flatter features of Orkney, with none of its interest, and but few of its minerals.

A patch of quartzite in the south—and nobody seems to understand how it got there, or what it belongs to; and a portion of an igneous rock of the adjoining county, which had thrust itself into the land, but stopped short chilled by the dismal swamp which lay before it.

Its two chief headlands have been mantled, and rendered somewhat more respectable by the upper sandstones of Hoy; but about the best that can be said of the county as a whole is, that its geology is *flags*, and its history is *fishes*.

Minerals.

The record is very brief.

In his paper on the Mineralogy of Sutherland, Cunningham writes,—"The solitary instance to which I allude is the discovery of *fluor spar* in the Ord of Caithness, a mountain forming the northern extremity of a granitic band, which stretches along a considerable portion of the east coast of the county. The point where this mineral was detected is in some precipitous cliffs overhanging the burn of Ousdale (Ausdale), and near a rocky ledge, over which the stream falls, at a short distance from its confluence with the sea.

The fluor occurs in the granite in two distinct modes, viz., as imbedded concretions, and as mere threads. The former I have never found larger than a small pea; and the latter, though they may have a length of several inches, were in no case perceived to have a greater breadth than a quarter of an inch. Its colour is the imperial purple of Werner's nomenclature, and the usual cuboidal crystalline form is in some instances distinctly developed."

To Dr. Joass, of Golspie, I am indebted for specimens of lamellar *baryte*, from Thrumster, about six miles south of Wick; and to the same gentleman and A. H. Gillieson, Esq., for *limonite*, with imbedded *rock crystal* from the banks of the Isald burn, near Achavarasdale in Reay. The limonite was granular and very siliceous; Dr. Joass failed, after much trouble, in procuring me specimens pure enough for analysis, though he believes that it is sometimes fibrous.

Upon the north shore, near John o'Groats House, *augite* occurs. It was found and sent to me for analysis by Professor Geikie, who on the 2nd November, 1879, wrote as follows:—

"You should receive to-morrow a parcel containing the pieces of the John o'Groat's augite.

I have not time to send you full particulars at present. It occurs in rough, rounded, and broken lumps, imbedded in the coarse agglomerate of a volcanic neck, belonging to the Upper Old Red Sandstone time.

I have had it sliced, and have examined it microscopically. It is not in the least dichroic, and has none of the other features of hornblende.

I have no doubt it is augite. Some of the rough granular pieces suggested, at first, olivine to me. But I found this granular character to be exceptional, and the mineral is fusible, and with hardness equal to 5·5.

It is by far the most interesting volcanic augite I am acquainted with."

On the 4th December, he writes:—

"The specimen I send you is one of a number of pieces of what seems to me to be a form of augite, which I have found in the most northerly volcanic rock on the Mainland of Scotland.

This occurs on the shore, half a mile to the east of John o'Groat's House.

While the whole of that part of Caithness lies upon the so-called "Caithness flagstones" of the Old Red Sandstone, the coast at the locality in question affords an admirable section of the red sandstones, with blue and grey flags and shales (sometimes with well preserved ichthyolites), which form the highest visible portion of the Caithness flagstones.

No igneous rocks of any kind are interbedded among these strata or in any other part of Caithness.

It was therefore with the utmost surprise that, when examining the coast line in the year 1874, in company with my colleague in the Geological Survey, Mr. B. N. Peach, I came upon a well marked volcanic "neck" or pipe, which had been drilled through the John o'Groat's sandstones.

I have no doubt that this neck marks the chimney of one of the Upper Old Red Sandstone Volcanoes.

I again visited Caithness last summer, accompanied by another survey colleague, Mr. John Horne, and made further notes about this interesting locality.

The neck is irregularly oval in shape; the diameter, on this edge truncated by the sandy beach, being about 300 feet. The sandstone round it is somewhat hardened and jointed, as may usually be observed in similar cases. The whole space of the neck is filled up with a coarse tumultuous agglomerate of a dirty green colour, which makes it stand out in strong contrast to the surrounding red sandstones. The paste of this rock is a granular tuff, formed evidently of comminuted diabase.

The blocks imbedded in it are angular, subangular, and rounded, of all sizes up to masses of a yard or more in diameter. I observed among them pieces of diabase (these form the great majority), no sandstone, grey flagstone, gneiss, and abundant fragments of the augite which I send you.

Some of the diabase blocks were of great size, but, as veins of a similar rock traverse the neck, it was not always possible to tell which were parts of veins, and which were really detached blocks. The augite fragments are all rounded, as if they had undergone considerable trituration before

they came to rest. Here and there they show a rough cleavage-face, which may have been produced by their striking against another ejected block. They vary in size from mere seed-like grains, up to blocks at least eight or nine inches in diameter.

No sign of fusion, or even of good baking, was to be seen in the bits of imbedded sandstone in the agglomerate.

I should add that I did not observe any minerals associated with the augite, except such as had resulted from the alteration of the tuff.

There cannot be the least doubt that the fragments of augite are true ejected blocks, and did not originate in the matrix where we found them.

They are by no means the only examples to be met with among the Scottish tuffs, though they are very much larger than any I have before observed. Next to these in size, were some which I found in a neck on the shore to the south of Fairlie in Ayrshire, belonging to the Lower Carboniferous volcanoes."

Upon examination, I found these specimens to be of a dark bottle-green colour, and a high vitreous lustre; their specific gravity was 3·36.

They yielded,

Silica	46·076
Alumina	11·391
Ferrous Oxide	7·921
Manganous Oxide	·461
Lime	16·067
Magnesia	15·653
Potash	·818
Soda	1·058
Water	·38
	99·825

These are masses therefore of an *augitic-glass*, somewhat similar to, but neither so much vitrified or flawed as specimens which I had myself previously discovered and analysed from Elie in Fifeshire, and the Giant's Causeway in Ireland.

It will be observed that Geikie remarks on the granular pieces suggesting olivine to him: which mineral the Elie specimens were considered by the writer to be, until their analysis established the occurrence of augite in this peculiar allomorphic condition.

The resemblance to olivine is, in the John o'Groat specimens, by no means—even in the most granular portions – so striking as in those already mentioned; while some portions of the specimens show the cleavages and fractures of unchanged augite.

This fact of the specimens presenting a changed and an unchanged portion,—having been caught or arrested in the middle of the process of change,—renders them certainly far more interesting, from the amount of information they convey, than those in which the glassy condition is perfect.

"Rough, rounded, and broken lumps," —the words well describe them as hand specimens. We will consider these features in a different order, that we may see what they teach.

"Broken";—"rough" because broken; and "rounded,"—that is partially rounded, or they would not still be rough,—rounded on account of some attriting action which operated after they had been broken.

Evidence of their having been broken,—i.e. that they are the fragments of a larger mass. Mere roughness could not prove this: the steam holes of igneous rocks though usually more or less spherical, and presenting rounded or curved outlines, are not invariably so; so that a mineral which ultimately plugged these, through endosmose, would, in the taking a cast of a rough cavity, assume a rough outline; while again, if the augite, after thorough fusion, was, on the abstraction of the heat, to assume the solid state, while the rock matrix was still in a plastic condition, it might form a confusedly crystalline mass with rough surfaces. That the roughness of outline is not here to be so explained, but is really due to irregularity of fracture, is shown *first* by large and fairly brilliant cleavages of the augite abutting against what have been the sides of the masses, as shown by a thin investing layer of calcite, and skin of chlorophæite(?)—and abutting at such an angle to these sides as could be formed neither by a crystalline arrangement which radiated from the sides of a cavity, nor by one radiating from the centre of the mass. The above cleavages, *secondly*, are of such size as show that they must have originally belonged to masses of much greater dimensions than those in which they are now found.

And, *thirdly*, the rough fractured sides occasionally exhibit, as also do internal fractures, portions of crystals of a size much too great to have been formed during the solidification of masses so small as these.

As regards the rounding, it amounts in general to little more than the abrasion of the protruding cleavage-angles, not to the giving a rounded outline to the general mass. The surfaces are now covered with a thin coating of calcite: the nature of the abrasions cannot be seen; it certainly has not been of the continuous nature of wave battering, or river grinding, or sand blowing.

As regards internal structure, there is here the same confused and hackly fissuring which I described in the Elie mineral, the fissures being, however,

narrower, and the whole mass more coherent; these fissures are, for the most part, filled with saponite (?) the probable result of incipient change and rarely with calcite.

The recent fractures are, like those of the Elie specimens, conchoidal though here and there true cleavages in broad sheets cross the conchoidal fractures, and even lie in directions non-accordant with the cleavages of the less altered portions of the mass; these latter having been, in fact, posterior in formation to the vitrifaction. The conchoidal fractures exhibit a perfect bottle-glass appearance, very similar to that of augite melted in a crucible. Close inspection with a lens, however, shows on the crystalline surfaces a cupped appearance, quite similar, though not so minute as that which, in decomposed glass, was shown by Sir David Brewster to be the cause of the iridescent colouring. Closer inspection still demonstrates that these cup-shaped hollows had been the receptacles of little spheroids of felspar, which may be seen arranged in layers in portions of the mass of the stone. I call the spheroids *felspar* merely from the lustre of their cleavages, and from the presence of alkalies, as shown by a partial analysis.

Two questions at once connect themselves with these "rough, rounded and broken lumps," which helped to choke up a former volcanic orifice.

The first—*whence came they, or what were they broken from?*

The second—*do they, in themselves, give us any information as to the amount of heat to which they had been subjected in the process of their vitrification?*

These two question may resolve themselves into the more general one—*is there any likelihood that we may be able,* by their recognition as components of a well known stratum, or by the amount of alteration which has been effected upon them by heat—*in any measure to arrive at an estimate of the depth at which the volcanic turmoil originated.*

Such a question is too wide a one to be entered upon in its entirety here; but although a consideration of it, in the two directions indicated above, may lead us but a small extent to any definite answer, yet to that small extent it unquestionably must lead us.

All *fragments* must have been brought by an outflow from beneath the parent rock from which the fragments were torn; the amount of change is the register of *the highest degree of the heat* which was the active agent of the change.

Asking ourselves in this instance, whence came these lumps of augite, we are able to reply unhesitatingly from no part of the Old Red: no formation, not even the chalk could have less claim *in itself* to an augitic mineral.

Inferior to the Old Red we have in this part of Scotland, gneissic and flaggy schists, thrown into wavy folds where they cross the breadth of Sutherland; these, where they underlie the sandstones here, are probably similarly crumpled, and have no great downward trend. Beneath these fractured and folded rocks again, we come upon the gently inclined beds of a highly silicious conglomerate; which beds vary among themselves not at all in the nature of their constituents, but only in the amount of attrition to which their component pebbles have been subjected; they are altogether destitute throughout of vein, or seam, or cavity, within which a crystalline or cleavable mineral had space or time to arrange its atoms.

Going lower still, we may walk for miles across the upturned edges of the rock, the beds of which strike vertically downwards with such an unvarying determination of purpose, that we are impressed with the whimsical fancy that if we ever again meet with them it must be when they come out at the other side.

After many traverses of the formations mentioned, my experience does not enable me to indicate any one spot or bed which could afford an augite the representative of this.

The Shinness limestone locality shows, throughout its great abundance of the mineral, no trace of such a variety.

I know of but one isolated occurrence of augite in the midst of the vast abundance of hornblende in the lower gneiss.

The well known conversion of hornblende into augite by heat may possibly account for its occurrence; but in this case a *double action* is required,—the first, that by means of which the transmutation was effected, resulting in the production of the broadly cleavable masess. The second, that which produced the final vitrification of these masses. Of any such double action we have here evidence only of the feebler,—the vitrifying.

The second part of our query, namely, the topmost limit of the heat to which the augitic lumps had been subjected, is more easily answered, seeing that a near approximation may be arrived at by direct experiment.

Many years ago I had an opportunity of determining the temperature to which fragments of different members of the lower Coal Measures had been subjected, when caught up among the ashes which form the small volcanic cones and necks around the shores of Fife.

In the shore sections of the wave-worn bosses of tufa which stud the coast near Kinkell, much fragmentary matter of various descriptions is to be seen promiscuously imbedded, and characteristically and instructively altered. The bituminous shales have lost all their illuminants; and, of

organic matter, retain only the blackening stain of sparsely distributed carbonaceous particles.

The encrinal limestone has become granular and crystalline.

The included freestone masses present themselves as a quartzite, with firmly agglutinated grains, splintery fracture, elastic resilience, and sonorous ring. Shivery masses of carbonaceous or "black chalk" clay show every stage of a passage into Lydian stone; while volcanic bombs of the latter, perfect in the transmutation, lie impacted in the encircling volcanic mud, with surfaces which exhibit rounding and abrasion.

We have here abundance of material to work upon, in estimating the quantum of the energy expended in the production of these changes.

Close observation of the altered calcareous fragments shows most clearly that the period of time, during which they had been subjected to the heat, had been of but short continuance; for while it will be found that the smaller of these fragments are, to their very centres, converted into a crystalline mass, reflecting light from innumerable facettes; the larger exhibit the change only to a certain depth; the interior presenting itself as an impalpable calcareous basis, studded occasionally with joints of the encrinal stems.

More than once I have found a larger than ordinary joint, in part converted into cleavable calcite, which flashed back reflected light, while the greater part showed the structure of the fossil in no degree effaced.

In the estimation of the temperature to which these erupted fragments had been heated, I operated upon the ordinary bituminous shales of the district, on the imbedded shaley coke which is found in the tuff, and on the bombs of Lydian stone imbedded therein.

First, as regards the shales, that from the Kenly burn, the nearest point where it crops out, yielded—

S.G.	Water	Gas	Carbon	Ash.
1·79	4·54	25·29	9.27	60·09

That from Kinkell imbedded in the tufa—

2·57	2·64	6·	·44	90·92

The gas from the latter is non-combustible, or almost so. The shale from the tuff is grey-black,—very dark when the small amount of carbon is considered.

From the Kinkell shale, therefore, the greatest amount of the gas and ater has been distilled off, and the greatest amount of the carbon burnt way.

It was next ascertained that the shales of the district parted with their as below a red heat, for antimony did not melt when inclosed along with iem in the retort in which the distillation was conducted.

In working downward as regards temperature, in order to ascertain the west point at which the change could be effected, the following process as adopted.

A flat block of iron, of some pounds in weight, had a dome-shaped vity turned out of one of its surfaces. On the surface of a large antity of lead which had been melted and cooled in an iron pot, a mber of fragments of the bituminous shales were placed, and covered ith the iron block, so as to be inclosed in and under the dome. The ad was melted in a dark room in a Bunsen furnace, which fitted closely und the sides of the pot, so that only the faintest glimmer of light caped from between the surfaces of contact.

Upon the melting of the lead, the floating iron sank slightly into it, fectually inclosing the shale fragments. Very shortly after the lead had quified, the iron was heard bumping against the sides of the pot; the und of bursting bubbles was likewise audible; and wreaths of a flicker- g lambent vapour, which reflected apparently more light than that hich escaped from the crevice in the furnace, were seen to ascend for a ight of a foot or more, from around the sides of the floating iron. The rm of the iron was clearly delineated in black shadow in the midst of ese luminous fumes, while the surface of the lead emitted no light hatever. Whether these gaseous exhalations be phosphorescent or not, e experiment was not arranged to determine, they so appeared. This sult sufficed to show that the organic matter could be and was driven out the shale at a heat below redness.

Finally a quantity of the shale was next enclosed in a capacious iron tort, along with a large quantity of mercury, the retort placed in a rnace, and the orifice of its tube conducted beneath jars filled with ater, and standing in the pneumatic trough.

There distilled over—*first*, water; *second*, carbonic acid, mixed with hite vapours of a hydrocarbon; *third*, a combustible faintly illuminating s; *fourth*, mercury along with vapours of paraffin, a highly illuminating s, and a quantity of one of the paraffin oils; *fifth*, mercury abundantly, uch heavy oil, and little feebly illuminating gas; finally after everything t mercury had ceased to distill, the retort was opened, when there was und much mercury remaining, with the fragments of shale, these

upon examination were found to be unaltered in shape and bulk, they had darkened in colour, and were somewhat greasy in appearance.

On being analysed they yielded almost no volatile ingredients, and about 5 per cent. carbon, which is less than when decomposed by a red heat.

These shales, therefore, are decomposed partially at a temperature somewhat below that at which mercury boils; and totally, as regards illuminants, at that temperature.

Upon the examination of the Lydian stone bombs, it was found that they contained 6·9 per cent. of water, of which 1·01 was hygroscopic; now this quantity of water is about the normal for that mineral;—the heat therefore had not reached the point at which Lydian stone is dehydrated.

In operating to discover the temperature at which Lydian stone is dehydrated, it was found to lose, when continuously heated just below visible redness 1·963 p.c.; at a feeble red heat a total of 4·272 p.c.; at a full red total of 4,503; and when heated to whiteness in the furnace 5·886 p.c. At the full red heat the powdered mineral slightly agglutinated, while at the white heat it fused to a blebby scoriaceous slag of a fawn colour—very similar in appearance to some vesicular lavas.

The data presented to us by the first experiments were that the shales had lost all their combustible ingredients, while the Lydian stone had not been deprived of any of its water. We have ascertained that the shales are totally decomposed at the temperature of boiling mercury, while the Lydian stone is partially decomposed at a heat below redness. We are therefore in a position to say that the temperature at which the ashes were finally ejected from the volcanic vents which ruptured the lower coal strata, probably lay between 660° and 900° Fah.

Let us now see what data we have to work upon, in attempting to estimate the temperatures at which ashes, cinders, mud and fragments of penetrated rocks, were ejected in Old Red Sandstone days.

As regards the augitic masses described, we have two circumstances to found upon; the first, that the included felspar—clearly one or other of the soda felspars—probably labradorite, had been so perfectly liquified that it had assumed spherical forms, a fact which also necessitates a *viscous* condition at least in those portions of the augite which included the felspathic spheres. The second, that we have, in the old cleavages and unaltered portions of the augitic masses, evidence either that the heat has not been high enough to vitrify them throughout, or that the period of time during which they had been subjected to that heat had not been sufficiently extended to enable them to be uniformly altered.

In other words, the heat had been such as thoroughly to liquify the felspar, but not such as thoroughly to liquify *masses* of the augite.

What heat then had sufficed?

The process employed in the determination of the water in labradorites had shown that mineral and the plagioclastic felspars generally to be liquified at the temperature of a full, but hardly a bright yellow heat.

The point of liquifaction of the augites varies largely, from readily fusible varieties to the almost infusible diallage.

Direct experiments on the mineral in question were therefore necessary.

Preliminary trials with the blowpipe showed that ordinary sized chips of the mineral were only rounded on the edges, or fused with difficulty, in the best flame that could be obtained; but when subjected to Fletcher's blowpipe, in which the air and gas are both passed through red hot tubes before combustion, a perfect glass, of a colour somewhat paler than the mineral, was readily obtained.

A quantity in chips and powder was heated at gradually increasing temperatures in a platinum crucible; it was found that the highest heat of a fine Bunsen burner had no effect in causing agglutination, even when the crucible was enclosed in a jacket. The crucible and its contents were now subjected to gradually increased temperatures in Griffin's blast furnace; at a bright yellow heat there was no change, and only when the crucible was at the point of bright ignition, approaching to a white heat, did the powder coalesce and liquify.

According to Pouillet, this accords with a temperature of 2200° or 2250° Fah.

This tends to the conclusion that the depth at which the volcanic force operated at the epoch of the Upper Old Red Sandstone was much greater than at the time when the lower coal was disrupted.

As I had myself no means of sifting from the many reports in newspapers the true from the false as regards the finding of gold in the streams of Caithness, I applied to Dr. Joass, of Golspie, and found that his experience was confined to an unsuccessful search in the Duke of Portland's land, and in the neighbourhood of the Scarabins, while he indicates reasons for receiving with caution and doubt all reported finds; this he does for reasons which will be considered when the Sutherland gold is spoken of.

I then wrote to Dr. Lauder Lindsay, who has taken an enthusiastic interest in the matter for long. From him I have received the following list of finds *reputed*.

"*Localities in Caithness of Gold finds, real or reputed, according to th newspapers of* 1869-70, *especially the* "*Northern Ensign*" (*Wick*), *a March and April*, 1869.

I. In the bed, over the banks of the Beriedele water, throughout it course, down to the sea beach.

II. In the Ord Burn, "in fair paying quantities."

III. In the Ausdale Burn ditto.

IV. On the Braemore estate (Sir Robert Anstruther's), through whic the Beriedele flows.

V. On the Langwell estate, on the flanks of the Scarabin Hills, b Gilchrist, the originator of the Kildonan diggings of 1869.

VI. In the Langwell water.

VII. In the Dunbeath water, and

VIII. In the Burn of Haster.

IX. In the Lathernwheel Burn.

X. Various localities, the parish of Lathern: "existence proven."

XI. In the Thurso River, at various points, such as Weyda Acharvadale, Halkirk, The Glut.

XII. In streams rising on Braemore.

XIII. In Strathmore, on Sir J. G. T. Sinclair's property

Special references to the *Caithness* gold localities are to be found in t "Northern Ensign" of February 4th, March 4th and 25th, an April 1st, 15th, and 22nd, all 1869.

In November, 1870, Sir J. G. T. Sinclair wrote to the "Norther Ensign," about gold that had been found on his property at Strathmor Several other newspaper correspondents describe the *Caithness* gold— comparing it with that of Kildonan, but they do not give their names, that the only "authentics" that can be cited in connection with *Caithne* gold are Gilchrist and Sinclair."

Dr. Lindsay thus reduces the "authentics" to two, and, as it is ver improbable that Sir J. G. T. Sinclair personally found or even sought f gold, it is probable that the "find" was of the same character as the oth "newspaper" ones. So that the flanks of the Scarabins would seem stand as the only indubitable Caithness locality.

The finest varieties of Caithness flags from the Castlehill quarries were nalysed by Dr. Hoffmann* with the following results,—a so-called "bitu-ninous shale" was also analysed—

	Top Flag	Middle	Bottom	B. Shale
Insoluble Silicates	68·4	69·45	61·39	69·96
Ferric Oxide and Alumina ..	10·21	11·5	4·87	8·15
Carbonate of Lime..	10·93	10 66	21·91	7·72
Organic Matter	3·88	5·79	3·4	10·73
Loss at 100° C.	·42	·4	·2	·53
Salts of Magnesia & Alkalies..	6·16	2·2	8·23	2·91

ADDENDUM.

Fearing that the absolute non-success in the discovery of the minerals hich had attended the few traverses which I made in Caithness (and hich had deterred me from further search in the county) might have ilitated against the fairness of my report thereon, I have, since the above as written, drawn upon the knowledge of my friend, Dr. Joass of Golspie, ho has interested Dr. Robert Gunn of Culgower, in the matter.

Dr. Robert Gunn applied to his cousin Mr. John Gunn, of Dale, Hal-kirk, who enthusiastically "made enquiries in every parish in the county;" he notes which follow are extracts from his letters, which convey the esults of the whole enquiry.

(1) Gold was found at Dirlot, but in small quantities. A whole day's ork of four men produced only a bit about the size of a common pin-head. his was the only specimen of Caithness gold I ever saw. I remember earing that gold was also found at Achardle, Harpsdale, on the Thurso. friend in the Murkle Estates' office tells me that he saw some which was ound somewhere near the Thurso river, but it was not much.

I am further informed that a gamekeeper at Strathmore, in this parish, ound a large quantity of the precious metal at the time when the Suther-and gold fever was at its height, but he would tell no one where the ocality where he made his find was situated. He is now dead, and I ear the secret has gone with him.

Iron was got in considerable quantities near Achavarasdale Lodge on n the property of Sir R. C. Sinclair. About 150 tons were shipped; it as wholly hematite and of first quality, and was found partly in vein and artly in *pots*. The vein was not followed to any great depth, and lthough the working was stopped some time ago, yet it was not because he ore was exhansted, but because the carriage was too much to allow of rofit. There was excitement some years ago about iron being discovered

* "Quart. Jour. Geol. Soc.", vol. xv, p. 402.

at Skinnet near Halkirk; and it was said that it was to be worked, but nothing came of it. Indeed, on making inquiries as to it, I can find no one who has *seen* iron-ore from that place, although several persons *say* it has been found there.

Iron-ore in small quantities was also found at Dirlot; as to its form it occurs in lumps of various sizes, but is of no value.

The Rev. Alex. Gunn, F. C. Manse, Walten, writes me:—

"With regard to the minerals of Caithness, I can give you very little assistance. As to metals, the field is a very barren one. I never heard of any gold being found in Caithness. Lead must also be rare, as I think it is generally associated with lime-stone, of which we have few deposits in Caithness. There is a small burn, about a mile or two from here where I have heard small cubes of galena or lead-ore have been found, but I never had the curiosity to examine the place. The only iron I know of is found in various places, in the shape of irregular lumps, on or very near the surface of the ground, and is, I suppose, a sort of impure oxide in combination with clay. It is sometimes ground and used as paint by joiners, and makes a very good brown paint. Springs are often impregnated with it, and drains choked. There are some spots in this neighbourhood where it is very abundant."

Mr. Gunn also tells me where I can get a copy of Capt. Henderson's History of Caithness—a book I never before heard of. I will try to get the loan of it, as Mr. G. says it contains a good account of the mineral works in the county in past times. If you have not seen the book I will send you such extracts as may appear useful.

I got a specimen of the Dirlot iron-ore (?) which proves to be nothing more than the impregnated clay spoken of by Mr. Gunn. I can get plenty of the same stuff almost anywhere in this district.

Silver and lead have been found at Skinnet, near Halkirk, both of average quality, and the latter has been also discovered at Borrowstone, near Reay. I am informed that a lot of lead (very near the surface) was lately discovered at Brawl, between Skinnet and Halkirk. I have succeeded in getting a specimen, weighing 3½lbs of this, which I forward. Please advise the arrival of it and of the hematite.

"The late Sir John Sinclair, Bart., of Ulbster had, in his day, parties prospecting for coal on and around Spittal Hill in this parish. Although they were unsuccessful yet they found *something* like what they were in search of. As this took place some sixty years ago, I am unable to say what the *something* was."

Mrs. Henderson, of Westerdale, has a limestone quarry on her property which she works; it is, I am informed, of very good quality. Limestone

was worked here at Dale, by my grandfather, the late Capt. Gunn, but the strata dipping it became at last too expensive to work."

Of the specimens kindly procured by Mr. Gunn and forwarded to me by Dr. Joass, I have to note that those from Achavarasdale are *limonite*, and not hematite as supposed by Mr. Gunn. One specimen is in well developed botryoidal forms, and has an appearance in colour and streak so intermediate between limonite and hematite that I regret much that its late arrival has prevented me from analysing it. In another massive granular specimen there are cavities lined with downy crystals, possibly of Göthite. A third specimen carries small doubly-terminated crystals of quartz, pleasingly stained and "capped" internally with yellow ochre. Taking the average of the specimens I have seen from the locality they are very far from "first quality."

The *galena* from Brawl is excellent, but its large foliation, and the dull blackness of its powder, indicate an unusually small percentage of silver. It had on it a small quantity of *cerussite*.

The Skinnet and Dirlot iron-ore is evidently *bog-iron-ore*.

Dr. Joass writes me—"I have come upon *a deed* among the Dunrobin papers which speaks of "all mines and minerals whatsoever whether Lead, Tin, Copper or even Coals," but which does not state that any traces of either were apparent. Anyhow nothing came of it."

"*Nothing came of it.*"—words used by Mr. Gunn also; they have to be written of all mineral enterprise in Caithness, whether scientific or sordid.

III.—*List of Newfoundland Minerals.*

By J. P. Howley, of the Newfoundland Geological Survey.

THE following list includes only such minerals as have come under my own observation, or that of such authorities as can be relied upon. Amongst the latter I may mention, Mr. John Milne, Professor of Mineralogy, Yedo, Japan; the late Mr. Hennessey, M.E., and Mr. Barclay, assayist, Belt's Cove Mine.

I have adopted Dana's nomenclature as that most familiar on this side of the Atlantic, and have arranged the names alphabetically, for convenience.

Alum shale.
Antimonite.
Apatite.
Argentiferous Galena.
,, Pyrites.
,, Quartz.
AUGITE.
Auriferous ,,
BARYTA (sulphate of)
Bismuth, traces.*
Bitumen (crystalline.)
Blende.
BRONZITE.
Cadmium, traces*
CALCITE, Iceland spar.
,, DOG-TOOTH spar.
,, NAIL-HEAD ,,
Chalybite.
CHLORITE.
Chromite.
Chrysolite.
Chloanthite.
COAL (bituminous)
Cobalt, traces*
COPPER, native
COPPER GLANCE.
COPPER PYRITES.
COPPER, Red Oxide.
Cyanite.
DIALLAGE.
DOLOMITE.
Enstatite.
EPIDOTE.
ERUBESCITE.
FELDSPAR, Orthoclase.
Fluor
GALENA.
GARNET.
Gold, native*
GRAPHITE.
GYPSUM, SNOWY.
,, SELENITE.
HORNBLENDE.
,, ASBESTUS.
,, ACTINOLITE.
HEMATITE
Horn Silver*
Hypersthene?
ILMENITE.
IRON PYRITES.

IRON JASPERY ORE.
,, BOG ORE.
KAOLIN (clay).
LABRADORITE.
MAGNETITE.
MALACHITE.
MANGANESE (carb. of)
MICA.
Millerite.
MISPICKEL.
Molybdenite.*
NICKEL COPPER.
OCHRE, RED & YELLOW.
Opal.*
Petroleum.
PSILOMELANE?
Pyrosclerite.
PYRRHOTINE.
QUARTZ.
QUARTZ, ROCK CRYSTAL.
QUARTZ, AMEYTHSTINE.
,, CHALCEDONY.
,, AGATE.
,, JASPER, FLINT, &c.
Rhodonite?
Rutile.
SALT (common)
SERPENTINE.
,, PICROLITE.
Silver, native*
,, Ruby.*
STAUROLITE.
TALC.
,, STEATITE.
TETRAHEDRITE.
Tombazite* (Gersdorffite)
TOURMALINE.
,, RUBELLITE.
Vivianite?*
WAD.

In the above list the large type indicates common species, those marked with an asterisk are rare, and the note of interrogation denotes doubtful minerals.

The apparent absence of many important groups, and the paucity of species generally, is not so much indicative of their non-existence, as of the fact that so few persons here are interested in their collection. Those who are at present engaged in the development of our mines, pay little attention to any minerals not of a commercial value; while my own opportunities of collecting have been hitherto chiefly prevented by an excess of topographical and geological work. I have no doubt that in course of time, however, I shall be enabled to add many others to the list, which is merely preliminary to a more extended one.

Newfoundland is just beginning to take its place amongst the mining regions of the globe; as yet her copper ores only have attracted attention. It is but reasonable to suppose that the time is not far distant, when many of her other economic materials will be profitably wrought. This supposition is founded on the fact that the latest rock deposit is of no more recent date than lower carboniferous, while the 42,000 square miles, which comprise the surface area of the island, are spread over by most of the older or pre-carboniferous formations. Many great belts of intrusive and metamorphic rocks cross the island

diagonally, or occupy immense areas, both in the interior and along the coast-line; in which frequent indications of various mineral substances are known to occur.

The absence of railways, or any means of interval transport, necessarily renders all products not immediately on the sea coast unavailable at present; and for the same reason it is now a difficult matter to get about the interior, or make any extensive collection of minerals, owing to the difficulty of conveying them hence.

In connection with this subject, a short notice of the principal mining localities, and the mode of occurrence of the ores, &c., may not be out of place.

The mines of Tilt Cove, Belt's Cove, Naked Man, Little Bay, Hall's Bay, Rabbit's Arm, and Seal Bay are all situated in the Great Bay of Notre Dame; the principal ores worked being those of copper. Yellow sulphide, of a low percentage, ranging from 6 or 7 per cent. to 30 per cent., forms the chief product. The low percentage of the ore in the abovenamed localities is counterbalanced by its abundance. Tilt Cove shipped between the years 1867 and 1873, 33,687 tons; and Belt's Cove, in less than five years from its inception, the enormous quantity of 95,000 tons. Little Bay mine was only opened in August 1878, and had shipped to the end of that same year 10,000 tons. The other localities mentioned above have only recently been opened up, and as yet there have been no returns from them. Copper ore occurs in many other parts of this Bay, often of a very promising character. The ore is found chiefly embedded in chloritic slate, or as at Tilt Cove, in a compact chloritic rock; but at Rabbit's Arm it occurs in parallel bands of quartz. Much of the ore in the slate bands presents the appearance of stratification, or at least corresponds with the bedding of the slate; even partaking of the various corrugations of the latter. Huge masses frequently occur, especially where the bed rocks are most affected by sharp folds, or otherwise disturbed.

Native copper is found sparingly in the Tilt Cove mine, and as thin films, frequently of a beautiful arborescent form, is also met with in a few other localities in this Bay. It occurs on the west coast of the island, in small strings and nodules, in Port-a-Port Bay and Bay of Islands; where it is found embedded in an amygdaloidal trap rock. Copper Pyrites is met with in many other parts of the island and nearly every one of its great bays, but nowhere in such quantity as in Notre Dame Bay. Variegated copper ore, copper glance, erubescite, tetrahedrite, &c., occur at several parts of Conception Bay, usually in quartz veins; and again on the east coast, and in Placentia Bay.

Beautiful specimens of what the miners term Peacock ore have come from the latter place.

Some of these ores are very rich, yielding between 75 and 80 per cent. copper; but hitherto, though several attempts have been made to work them the result has been in each case an unprofitable one. Nickel has been found by analysis, together with Cobalt, in many of our serpentine rocks, but the former ore has only been met with in workable quantities at Tilt Cove. One hundred and sixty-five tons were shipped from there previous to the recent fall in price.

Copper Nickel and Chloanthite are the principal ores, small quantities of Millerite and Tombazite (Gersdorffite) being associated with them in a gangue of a dolomitic character.

Iron ores are abundant in the island, and are found in association with all the copper ores, especially pyrites, which forms fully half the products of these mines. Magnetic iron, in great masses, accompanies the Tilt Cove copper ore, but occurs more sparingly at the other mines. It is met with also in several other localities, notably, amongst the Laurentian granites and gneiss. Chromic iron in association with serpentine rocks, frequently occurs. All the other ores of iron mentioned are quite common, being generally distributed over most parts of the island.

Lead (galena) is also a pretty generally diffused ore, but has so far only been worked in one or two localities. Its gangue is either calcspar or quartz, except in one noted instance, at a place named Laun on the southern coast, where it occurs in a matrix of greenish fluor spar. The ore has been worked for many years at the La Manche Mine in Placentia Bay, from a vein of calcspar averaging 6 feet in width, which was well charged with galena, and contained also a little copper pyrites. Beautiful amethystine quartz crystals were found lining vughs in this vein, which also yielded the opal mentioned, the only one I have ever come across.

Lead has been worked in Port-a-Port Bay in a matrix of crushed carboniferous limestone, which afforded a considerable quantity of ore, but the work had to be suspended, owing to the anomalous position in which we are placed in reference to that part of the island. Most of the galenas contain a small percentage of silver. It has also been found by analysis in an ore of iron from Bonairsta Bay, and in quartz from Bay of Islands. Native silver, horn silver, and ruby silver, in small quantity were taken from the Laun Lead Mine referred to above.

Gold has as yet been found but sparingly in quartz veins; some go
specimens were recently brought from the neighbourhood of Brigus
Conception Bay. Its existence in quartz from several localities, a
also in some of the iron and copper ores, has been proved by analysi
and there is every reason to believe that ere long it will be met wi
in quantities sufficient to render it of economic importance.

Zinc Blende is usually found in association with the lead and copp
ores, but not in any great quantity. A reddish variety from the La
Mine yielded traces of cadmium.

Rutile occurs in vitreous quartz in White Bay.

Molybdenite also in quartz, has only been found at Deer Lake,
the Humber River.

Antimonite, associated with galena and zinc-blende, is found
Morton's Harbor, in Notre Dame Bay. Manganese in the form
wad is very common. A massive black variety which I have cal
Psilomelane? and also Rhodonite? forms a considerable deposit n
Topsail, in Conception Bay.

Baryta, or heavy-spar is a pretty abundant mineral; a wide ve
having a pinkish tinge, is seen near St. Brede's in Placentia Bay.

Coal is confined to the carboniferons areas on the western side
the island; one in St. George's Bay, and the other near the head
Grand Pond on the Humber River. In the former area several sma
seams are known to exist, only two of which appear to be of sufficie
thickness to be economically important. During last summer a bo
hole was tried in the latter area, which resulted in the finding of fi
small seams, the largest of which was but 1·4 inches. Gypsum
immense masses, frequently of a superior quality for stucco work
accompanies the lower carboniferous limestones in these region
Veins of beautiful selenite are met with at times traversing thes
masses.

Petroleum in small quantity is seen oozing through the sand o
Shoal Point, Port-a-Port Bay.

To enter into particulars of the various localities in which the mor
common earthy minerals occur would render this paper needlessl
long. It will be sufficient to state generally, that the siliceous varie
ties are common throughout the island, while those partaking mor
or less of a magnesian character, usually accompany the metamorphi
serpentinous groups of rock.

The aluminous varieties, especially the felspars, labradorites, gar
nets, tourmalines, cyanites, staurotides, micas, &c., are found in

abundance amongst the rocks of Laurentian age, but are not all confined to this formation.

The crystalline Bitumen, which was obtained from a brecciated trappean mass, intersecting Lower Silurian limestones, &c., in Port-a-Port Bay, seems to have resulted from the heating action of the igneous mass coming in contact with a set of bituminous limestones and shales. It is from the latter rocks also that the Petroleum is derived.

Brine springs, containing much saline matter, accompany the gypsiferous deposits of the carboniferous formation, and the rocks in their immediate vicinity are frequently incrusted with a fine coating of salt.

It may be worthy of note that the ruby silver, found at Laun, has not, I understand, been met with any where on the continent north of Mexico.

IV.—*On a peculiar pasty form of Silica, from a cavity in Gold-bearing Quartz.*

By A. French.

THE alluvium over an area of about 50 square miles around Lead hills in Lanarkshire, is auriferous. In many places the precio metal may be rendered visible after fifteen or twenty minutes washi with the primitive wooden trough employed by the local gold-seeker Frequently nuggets have been found weighing from one to four five pennyweights, and these are often either contained in pieces loose quartz, or have quartz fragments attached to them; there a therefore good reasons to believe that the gold found in the red stratu of clay lying immediately above the rock has been derived from th numerous quartz veins which traverse the district.

The author was one day searching, along with some friends, for gol quartz *in situ*, and while examining a vein which crosses a gulch i the hills, called the "Gold Scars," found cavities in the quartz fille with a peculiar pasty substance, which appeared at first sight lik minute scales of silver, which had been precipitated from a solution Our first impression was that it was silver, but its behaviour in wate soon cleared away the delusion; it rendered the water exceedingly turbid and white, and the suspended matter was a long time i settling. It consists of very minute scales of silica, somewha lenticular in shape, their sizes vary from $\frac{1}{2000}$ to $\frac{1}{6000}$ part of an inch.

It is not attacked by hydrochloric or sulphuric acids, but is easily dissolved by hydrofluoric acid, and by a moderately dilute solution o sodium hydrate.

It is a rather remarkable feature of the Lead Hills district that the lead and gold bearing ground is bounded on four sides by particular kinds of quartz. On the southern boundary Lydian stone is found in great abundance. On the north at Abington, red jasper prevails towards Crawfordjohn on the west agates and cornelians are found —these are sometimes of great beauty; and on the east near where this specimen of silica was found, calcedony is often found.

The whole field is contained within the Lower Silurian, the palæontology of the district is exceedingly meagre, but mineralogically it is very productive.

In the discussion which ensued on the reading of this paper some doubt was expressed as to the substance being really silica. Some members thought it was rather a sub-carbonate or other sub-salt of lead. I therefore requested Mr. Collins to test the small portion which I had previously placed in his hands for exhibition at the meeting.

He reports as follows:

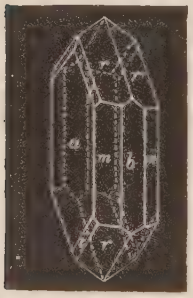
"The quantity of material placed at my disposal was too small to allow of a proper chemical analysis by humid methods. I have, however, obtained very definite results by pyrologic tests. Thus, I found it unaltered in the closed tube, however strongly heated; it effervesced strongly when fused into a bead with carbonate of soda, and it remained insoluble in a bead of microcosmic salt. These results are quite sufficient to prove the presence of silica, and the absence of such bases as colour a bead of microcosmic salt. The absence of alumina was shewn by the nitrate of cobalt test. On the whole I see no reason to doubt that it is really silica as you say."

V.—*On a new face on crystals of Stilbite, from two localities.*

By Professor Heddle.

MANY years ago I observed upon crystals of the red stilbit which was at one time obtained near Loch Humphrey, and at th Long Cray, in Dumbartonshire, a face which is between *r* and *a* Brooke and Miller.

More lately I have observed a face which also lay in the sa position upon the crystals of a specimen ticketted as from Farruga Wuardi, near Mount Nombi, west side of Wellington Plains, Austra



In none of the specimens which I have, was t face very smooth; and having failed to obtain bett I now note it, though the measurement can little better than an approximation.

In the Australian specimen the angle *a t* = 15 32′ to 153°.

On the Scotch specimen it is rougher from its bei striated parallel to its intersection with *a*; it seem about 149°45′ to 150°. I have little doubt, howeve that it is the same face as that on the Australia crystals.

Reviews and Notices.

Chapters on the Mineralogy of Scotland, by Prof. M. Forster-Heddle, F.R.S.E.

Trans. Royal Soc., Edinburgh, Vol. XXIX, Chap. VI.—Chloritic Minerals. Read 3rd March, 1879.

ANOTHER of our esteemed President's interesting "chapters," not less important than those which have gone before.

The author commences his paper with some general remarks upon mineralogical classification, and upon the use of the terms "chlorite" and "chloritic mineral," as follows:—

> There is no department of natural science which is so defective in its general scheme of arrangement as mineralogy; and its sectional grouping is, if possible, still more defective.
>
> Such correlations as are expressed by the terms, "The Micas," —"The Felspars,"—"The Garnets," &c., are only admissible if the substances united in such groups are included under one general formula, and function in a more or less similar manner as rock-formers.
>
> Under such methods of arrangement as are in vogue, many substances are left to stand isolated as intermediates,—substances which frequently form important integers in a regular sequence. And when such groups are constituted upon the possession of merely some one general feature, it almost invariably results that there are linked together substances which have nothing else in common.
>
> Mineralogy presents numberless examples of the misleading effect of being guided by mere externals; and the more the *geognostic relations* of minerals are sought out, the more clearly do we see the false conclusions with which we are drawn when we *are* guided by externals alone.
>
> To no group does this apply more emphatically than to that of "*The Chlorites*" Of the twelve minerals which in our systems find a place therein, some are the products of mere solution—some of direct chemical change,—some of metamorphic transmutation. Of these, some are found in sedimentary rocks, some in volcanics, in limestone, in serpentine, in schists, in granite, and in traps.
>
> The extreme injudiciousness of founding a natural history group upon so trivial a character as *colour* alone, is shown by the laxity which has gradually crept in, by the expanding as it were of the name into "the Chloritic group," or "Chloritic minerals."

From the difficulty of discriminating between several su stances which fall under such a term, there can be no dou that it has not unfrequently been adopted as a convenient cov for ignorance.

"I always say *chloritic minerals* when any of my studen ask me what they are,—it covers a vast amount of ignorance This was the remark made to me by a teacher of geology, wh we were discussing the green substances which plug the ste holes of anygdaloids. The deductions to be drawn from t present investigation, will show that the term employed inste of covering, *exposed* that which it was intended to conceal.

From the very frequent occurrence of diffcultly-recognisa green minerals in volcanic rocks, it is to them that this term chloritic is now *specially* applied; it is so applied in the beli that the mineral is a chlorite of some kind, and this is c ceived to be quite a sufficient amount of knowledge.

In proof that there has been no overstatement in the forego remarks, Dr. Heddle refers to Mr. J. Clifton Ward's "Notes on occurrence of Chlorite . . . . in the English Lake District,"* and the writings of Von Cotta, who, in defining diabase says "and sc chlorite" . . . . "The green colour of the rock is chiefly owing to chlorite.

"The most marked feature of its difference from dolerite is chlorite, and its consequent green colour. If this chlorite b product of transmutation, then all the original difference tween diabase and dolerite probably consists in the level depth of solidification."

Dr. Heddle continues :—

It is significant that Cotta does not enumerate chlorite amo the minerals accessory to diabase, its clefts and veins; while says "the vesicular cavities are filled with . . . chlorite, gla conite . . . . and the like." It is well known that the veins a rock contain the materials of its general structure in gia development of crystals, while its amygdules contain the pr ducts of the transmutation thereof, through aqueous chang and transfer.

Lately, however, clearer light is beginning to be thrown c the matter, for we have Dana supporting Rosenbusch, when H says that chlorite is not an essential characteristic of diabas and those who look in Scotland for chlorite in rocks, in all oth respects entitled to the name of diabase, will certainly fi none.

If we are to accept and found upon the above admission namely, that the amygdules of these so-called chloritiferous vo

* Since this review was placed in the printer's hands, the untimely death of th most active and able geologist has been announced—to the great and we fear permane detriment of the Scientific Societies of Cumberland, for whom he acted as a bond union.

canics contain the material which, diffused in a minute-granular or flakey condition throughout their mass, imparts the occasional green tint, then analysis has determined that material to be in no way connected with chlorite, except in colour.

The results of the following investigation go to show that the minerals usually thrown together under the term which I somewhat unwillingly adopted as the heading of this chapter, are to be grouped under two absolutely distinct heads. For the first, the old term of *the chlorites* may be retained; to the second, the term *the saponites* may be applied, from the unctuous feeling, which is a marked characteristic of them all.

So far as the evidence of over fifty analyses, and much contingent observation, entitles me to speak, the members of the first of the groups are found only in sedimentary and metamorphic rocks, never occurring in volcanics; the second are confined invariably to the latter, never being seen in the former class of rocks. The members of the first are not decomposed by chlorhydric acid, and there is no peculiarity in the manner in which their constituent water functions.

The members of the second are (with one exception) readily decomposed by chlorhydric acid, and the mode in which a portion of their constituent water is held in combination is anomalous.

The first are to be regarded as constituents of the rock mass which contains them, paragenetic in time with the minerals associated with them. The second are products of the degradation of the primal constituents of the rock, and are compounds of a more stable nature than the originals which yielded them through a destructive change.

So far as I have yet ascertained, the following members of each of these groups occur in this country.

	Chlorites.	
Glauconite	Penninite	Chlorite
Talc-chlorite	Ripidolite	Chloritoid
	Saponites.	
Delessite	Hullite	Celadonite
Chlorophæite	Saponite	

As regards *the Chlorites*, after some general remarks upon the ysical characters, which the author says "lend scarcely any aid, if y do not even somewhat confuse" as regards their determination, d referring to the dearth of information as to the geognostic re- ions of minerals, Dr. Heddle proceeds to describe in detail the alities, modes of occurrence of each of the Scottish species, and es full chemical analyses—these latter being epitomized in table 1.

Table 1.

PENNINITE.

	S. G.	$\dddot{Si}$	$\dddot{Al}_2$	$\dddot{Fe}_2$	$\dddot{Cr}_2$	$\dot{Fe}$.	$\dot{Mn}$.	$\dot{Ca}$.	$\dot{Mg}$.	$\dot{K}_2$	$\dot{Na}_2$	$\dot{H}_2$	Totals.	Matrix.
Scalpay, Harris	3·099	30·41	11·58	2·34	...	10·71	1·19	tr.	30·63	·01	1·31	11·74	99·92	Serpentine
Corrycharmaig, G. Lochy...	2·895	34·31	13·64	·36	tr.	10·31	·23	8·97	18·04	1·36	·13	12·41	99·75	Mica slate.
Kammererite—														
Unst, massive	3·099	29·89	12·93	...	5·97	1·96	...	3·54	29·93	1·16	·97	13·27	99·62	Serpentine
Do., crystallised...	...	32·31	7·5	...	7·89	2·08	...	3·83	32·15	...	...	14·25	99·9	Do.
Pseudophite or (?) *Pyrosoclerite*—														
Beauty Hill, Aberdeen ...	2·59	34·73	12·44	...	...	2·68	1·17	1·6	34·1	...	...	13·1	99·82	Gabbro.

RIPIDOLITE.

Blair Athol	...	30·3	19·4	...	...	8·23	·37	...	29·1	...	...	13·07	100·47	Limestone
Hillswick, Shetland	...	32·55	13·95	·97	...	5·28	·16	·79	32·78	·48	·06	13·17	100·19	Chlorite slate
Cape Wrath...	2·823	31·03	14·85	5·73	...	17·42	1·	·36	17·42	...	...	12·48	100·29	Hornblendic gneiss
Aphrosiderite—														

	S. G.	$\dot{Si}$.	$\dot{Al}_2$	$\dot{Fe}_2$	$\dot{Cr}_2$	$\dot{Fe}$.	$\dot{Mn}$.	$\dot{Ca}$.	$\dot{Mg}$.	$\dot{K}_2$	$\dot{Na}_2$	$\dot{H}_2$	Totals	Matrix.
CHLORITE.														
Fethaland, Shetland	...	24·3	20·86	3·57	...	16 72	·55	·5	22·2	...	...	11·55	...	Mica gneiss.
Ben Derag. Perthshire ...	3·002	24 72	21·57	·62	...	26·16	·47	·45	12·86	1·73	·05	10·89	99 51	Mica slate.
Craig-an-Lochan, do ...	2·697	24 29	21·18	·10	...	18·74	·8	1·66	21·03	1·29	·56	10 08	99·7	Do.
Lude, do ...	2 852	23 92	22·98	1·11	...	19 54	·28	2·45	17·26	...	...	11·78	99·39	Limestone.
Do., do ...	2·852	24 66	23 19	·64	...	20·58	29	·4	17·79	...	...	12 12	99 66	Quartz in ditto.
Loch Laggan. Inverness ...	2 834	26 25	19·22	1·67	...	16·44	1·02	...	24·35	...	...	11·67	100 62	Limestone.
Portsoy, Banffshire	2 792	26·71	20·42	3 47	...	13 99	·73	...	23·9	...	...	11·17	100·39	Chlorite slate.
Girdleness, Kincardine ...	3·038	24 77	20·16	1·38	...	27·39	·61	·9	13·34	...	...	12·05	100·59	Granite vein.
											...			
CHLORITOID.														
Hillswick, green...	3·387	24·47	41·34	·38	...	18·52	·91	·3	6·8	...	...	6·98	99·71	Mica slate
Do., brown	3·356	25·36	41·74	3·89	...	13·93	·92	90	6·82	..	...	6 57	100·41	Do.
TALC-CHLORITE.														
Hillswick	...	39·81	11·43	...	...	7 97	·26	2·80	25·68	1·2	3·15	7·91	100·19	Chlorite slate
GLAUCONITE.														
Ashgrove, Eligin	...	49·09	15·21	10·56	...	3·06	...	·55	2·65	6·05	1·21	11·64	100·02	Cornstone.

He then does the same for *the Saponites*—the analyses being given in table 2.

TABLE 2.

DELESSITE.

	S. G.	Loss at 212°	$\ddot{S}i$.	$\dddot{A}l_2$	$\dddot{F}e_2$	$\dot{F}e$.	$\dot{M}n$.	$\dot{C}a$.	$\dot{M}g$.	$\dot{K}_2$	$\dot{N}a_2$	$\dot{H}_2$	Total.
St. Cyrus, Kincardine	2·652	2·744	32·69	13·44	4·4	6·62	...	·86	28 77	...	...	13·25	100 02
Bowling Quarry, Dumbarton ...	2·573	5·7	32·	17·33	1·19	12 45	...	1·57	20·42	...	...	15·45	100 4
Dumbuck, do. ...	2·598	6·3	32·01	18·87	1·18	12 09	tr.	1·39	19·64	...	...	15·16	100·64
Long Craig, do. ...	2·656	4·678	30 93	15·32	3·16	15·31	·38	1·38	18·65	...	...	14·69	99 82
Elie, Fifeshire...	2 672	3·389	30 69	12 83	1·63	18 32	1·	1·59	18 6	·57	1·11	13·77	100 11
Average	2·63	4·562	31 26	15·56	2·32	12·96	...	1·38	21·22	...	...	14·52	...
Formula	...	...	31·53	16 28	2·8	12·61	...	...	21·02	...	...	15 76	...

CHLOROPHÆITE.

Scuir Mohr, Rum	...	19 227	36·	...	22 8	2 46	·5	2 52	9·5	tr.	tr.	26·46	100·25
Giant's Causeway, Ireland	2·278	14·156	35·99	10·49	11·89	1 63	·08	5·15	10·52	·34	·76	23·2	99·99
"Hullite" (hydrated)	...	...	35·06	9·21	18·42	3·25	tr.	3 99	6·65	...	...	23·2	99·78

HULLITE.

Kinkell, Fifeshire	...	8·029	38·59	17·34	15·97	n. d.	1·56	3 94	8·65	·67	...	13·48	100·2
Carnmoney (Hardman)...	1·76	...	39·44	10·35	20·72	3·7	...	4·48	7·47	...	...	13·62	99 78
Average	...	...	39·	13·84	18 35	3·7	...	4·48	8·06	...	...	13·5	...
Formula...	...	...	38·77	12·44	19 38	3·55	...	4·04	8·72	...	...	13·1	...

SAPONITE.

	S. G.	Loss at 212°	$\dot{S}i$.	$\dot{A}l_2$	$\dot{F}e_2$	$\dot{F}e$.	$\dot{M}n$.	$\dot{C}a$.	$\dot{M}g$.	$\dot{K}_2$	$\dot{N}a_2$	$\dot{H}_2$	Total.
From "Old Red" Volcanics—													
Gapol, Kincardineshire	2·179	15·746	42·13	7·25	6·57	·19	·13	·8	19·33	·58	2·09	21·07	100·14
Kinneff, do. (green) ...	split	14·092	42·1	5·95	4·96	·18	·09	2·15	20 98	·28	·46	22·93	100·08
Do. do. (purple) ...	2·28	14·52	42·5	5 88	4·91	·12	·12	2·13	20·74	·19	·47	22·75	99·79
Glen Farg, Perthshire	2·235	12 961	36 54	9 39	2·85	5·25	·15	2·5	21·62	..	...	21·68	99·97
Wormit Bay, Fifeshire	..	13·87	42 84	4·83	6 5	2 36	·2	2·16	21 81	tr.	...	20·7	101·39
Tayport, do.	2 282	13 96	40 11	6·49	5 61	2 37	tr.	2 01	21·67	·32	·21	21·6	100·38
Catkin Hills (scaly)	2·279	15 61	41 34	10·53	1·86	3·84	·09	1·22	21·07	·05	·37	19·48	99·48
Do. (fibrous) ("Bowlingite")	2·288	14·76	42 22	8·52	2 99	4 88	·07	·92	21·23	...	...	19·49	100·31
Bowling Dumbarton (do.)	2·308	12 315	38·08	6·26	4·36	4·98	·23	2·97	21·46	·95	·11	20·48	99·96
Do. do. (Mr. Dalziel)	...	12 965	36 74	5·35	5·94	6·96	·08	3 06	20·22	·49	·21	21·28	100·31
From Secondary Volcanics—													
Storr, Skye (olive)	2·296	13·652	41·41	9·08	2·05	...	·11	1·86	22·8	...	..	23·43	100·72
Quiraing, Skye (white)	split	15·536	42·5	5 06	·85	...	·23	3·27	23·95	·17	·45	23·68	100·14
Do., do. (yellow)	split	15·132	40·33	8·72	1·97	...	·13	2·8	21 71	...	...	24·34	99·99
Average	2·272	14·22	40 63	7·18	3·96	2·38	..	2·14	21·43	...	...	21·76	...
Formula...	...	...	40·81	7·5	3·88	2·62	...	2·04	20·61	...	...	22·73	...

CELADONITE.

Scuir Mohr, Rum	2 574	5·99	57 72	·33	17·05	3·73	·08	·6	3 84	5·55	·42	10·78	100·2
Tayport, Fifeshire	2·59	5 018	52·69	5·79	9·75	5·37	·31	1 16	8·54	6·21	·39	10·48	100·68
Wormit Bay	2·598	3·879	52·54	5 82	9 71	5·4	·3	1·29	8·31	6·5	·64	10·41	100·93
Giant's Causeway, Ireland	2·63	1·364	56·41	2 14	14·07	5·09	·23	·6	5 91	8·83	...	6·79	100·29
Average	2·598	...	54 84	3·52	12·64	4·9	...	89	6·65	7·	...	9·62	...
Formula...	...	...	54·05	3·83	11·94	5·4	...	...	6·76	7·88	...	10 14	...

These tabulations present clearly to the eye the distinct features of these allied minerals, which are therein arranged in t order of their content of Silica.

The following formulæ are then given for the five *Saponites*—

Delessite $(\dot{F}e^{\frac{1}{2}}\ \dot{M}g^{\frac{1}{2}})^2\ \ddot{S}i^2+(\ddot{A}l_{2\frac{1}{10}}\ \ddot{F}e_{2\frac{9}{10}})\ \ddot{S}i+3\dot{H}_2+2\dot{M}g\ \dot{H}_2$.

Hullite $(\dot{F}e\ \dot{C}a\ \dot{M}g)^4\ (\ddot{A}l_2^{1\frac{1}{2}}\ \ddot{F}e_2^{1\frac{1}{2}})^3\ \ddot{S}i^3+9\dot{H}_2$.

Saponite $(\dot{F}e\ \dot{C}a\ \dot{M}g)^6\ \ddot{S}i^6+(\ddot{A}l_2^3\ \ddot{F}e_2)\ \ddot{S}i+13\dot{H}_2$.

Celadonite $(\dot{F}e^{\frac{1}{2}}\ \dot{M}g^{\frac{1}{2}}\ \dot{K}_2^{\frac{1}{2}})^3\ \ddot{S}i^0+(\ddot{A}l_2^{\frac{1}{2}}\ \ddot{F}e_2^{\frac{1}{2}})\ \ddot{S}i^2+5\dot{H}_2$.

Chlorophæite Formula not evident.

Or, in atoms—

Delessite $\dot{R}^4,\ \ddot{R}_2,\ \ddot{S}i^3\ \dot{H}_2^5$.

Chlorophæite $\dot{R}^4,\ \ddot{R}_2^8,\ \ddot{S}i^7,\ \dot{H}_2^{16}$.

Hullite $\dot{R}^4,\ \ddot{R}_2^8,\ \ddot{S}i^3,\ \dot{H}_2$

Saponite $\dot{R}^6,\ \ddot{R}_2,\ \ddot{S}i^7,\ \dot{H}_2$.

Celadonite $\dot{R}^3,\ \ddot{R}_2,\ \ddot{S}i^8,\ \dot{H}_2^5$.

In the above investigation every substance, the nature which was at all doubtful, of which I could obtain a sufficien for analysis was examined.

In applying the results of the examination to the consid ation of the geognostic relations of these minerals, those the first or true chlorite type may be dismissed in few words.

With the exception of the occurrences of chlorite at t Girdleness and at Rubislaw in granite, the minerals of the fi class are to be found *only in metamorphic rocks.*

Glauconite, occurring generally in rock which is believed be of recent origin, may, by its occurrence, aid somewhat assigning the age of certain doubtful strata.

The second group, which I have called the saponites, belo *solely to igneous rocks ;* and, from the mode of their occurrenc there is no room for doubt that *they result from the alteration certain of the constituents of these rocks*—augite and olivine in probability.

As regards our power of distinguishing them from ea other, this is by no means so difficult as their want of form a general similarity of appearance would at first sight lead one suppose.

Delessite can be distinguished from chlorophæite by its d lustre, its minutely granular structure, its opacity, and its colo —in the field; and rapidly in the laboratory by its much high

gravity, its much smaller loss at 212°, and much smaller total content of water.

From the specimen of Hullite found at Kinkell, I could not by physical properties undertake to distinguish it;—the darker varieties of Delessite at least much resembled that specimen.

From saponite, Delessite can be distinguished by its dark colour and granular structure and its opacity; and in the laboratory by its high gravity and its water.

From celadonite it could not be distinguished either by its structure or opacity, or by its gravity, or satisfactorily by its water content; but its colour, and its solubility in acids, at once suffice to separate the two.

Chlorophæite is readily recognised; when fresh it resembles a green jelly,—when weathered it equally resembles drops of asphalt.

The Kinkell Hullite resembles a dark Delessite, and therefore does not resemble chlorophæite.

Saponite, it its usual green form, is easily known; its extreme softness, greasy lustre, great translucency and soapy structure suffice to define it in the field; the extreme readiness with which it parts with and regains so large a quantity of water equally suffices in the laboratory, while its low gravity is of itself characteristic.

The white variety is by no means so readly identified; halloysite, conite, the magnesian carbonate of lime, agaric mineral, and a peculiar superhydrated vein-serpentine, all closely resemble it.

Celadonite may at once be known by its insolubility in acids; its loose-granular or mammillated structure, its perfect opacity, and brilliant colour, are likewise well-marked characters.

Such are the minerals occurring in Scotland, which are without question to be referred directly to one or other of the above species.

The author then gives a description of the new mineral *Bhreckite*, already described in the *Mineralogical Magazine* (p. 57, vol. 11), and of *Rubislite*, a mineral much like a *Hullite*, in which much of the iron is in a ferrous condition, and which was found in the red granite of Rubislaw.

The paper concludes with the two following "supplements."

Supplement to Saponite.

In a letter from Professor King, received since the foregoing analyses of saponite were executed, he writes:—

"According to Haughten, saponite occurs with serpentine in Cornwall. Some specimens I collected there I take to be the same mineral; but it is not 'soft like butter or cheese,'—it is hard, something like

serpentine, and may be actually a white or cream-coloured serpentine. The specimen laid by for you will settle the point. I should like to see your saponite."

This sentence led me to compare the specimens which I have called what I have called the "super-hydrated vein-serpentine" with the descriptions of saponite given by Dana,—and my analyses of these specimens with the column of analyses to be found at page 472 of his work.

While the physical properties assigned to saponite by Dana agree perfectly with those of the specimens which I have analysed, and therefore warrant my assigning the name to the Scotch specimens, it cannot be said that the claim of certain of Dana's specimens to the name is altogether beyond a doubt, and this on account of the most characteristic of the features of the Scotch mineral—namely, the low temperature at which it parts with some of its water—not having been observed in the specimens hitherto ranked as saponite. When, however, the *analyses* given by Dana are considered, there is no room for doubt that some of the substances analysed should not have found a place there, and there is even room for doubt if any but the *thalite* of Owen should.

Nothing, but their having suffered such a loss of water as I have pointed out as likely to occur through exposure to heat during carriage, could entitle us to associate under one name substances varying in their content of water to such an extent as from 10·5 to 20·66 per cent.—a variation which so far explains, though it hardly justifies, Dana's remark, that "analyses give naturally no uniform results for such an amorphous material." Had it been said that the name had been applied to substances which, filling the steam-holes of volcanic rocks, were unquestionably the products of change or degradation,—possibly not always of the same nature, or of the same material,—such a remark might legitimately be made. It is, however, a fairer inference that the analyses give no uniform results, because *different substances* have been included under one name.

And this inference is borne out in a marked manner by a consideration of the peculiar substance which fills the rents in serpentine rocks; and this consideration leaves little or no doubt that the so-called steatite or seifenstein from Cornwall and from all serpentine rocks must be withdrawn from the species, and that the name must, as I have shown above, be in future confined to one of the materials which plug the amygdules or rarely the rents of *igneous rocks*.

The suggestion of Dana's that as, if we suppose the alumina to be present as *kaolinite*, the rest is a silicate allied to *aphrodite*,—*as if the*

ineral were a mixture of the two,—I cannot regard as sound, for the ro reasons that, according to Dana himself, neither kaolinite nor hrodite occur in volcanic rocks (nothing of the kind is to be seen in e Scotch ones), and because, as he himself states, kaolinite is not composed by acid, while saponite is.

Any admixture "as kaolinite," with a mineral soluble in acid, ould after treatment therewith disclose itself by remaining as an in-luble residue.

The features, so far as I have yet attained to the recognition of them, hereby this super-hydrated vein-serpentine can be discriminated from ponite, are the very much smaller amount of its loss of water when ated,—its smaller content of water,—and a peculiar opalescence and rasol appearance, which it presents, when transparent varieties are oked through.

In five analyses of these "vein-serpentines" from Scotland which I ve executed, I have found the quantity of total water to lie between ·16 and 16·58 per cent.; and of this the loss at 212° ranged from 63, which was that of the lowest total, to 3·53, which was that of the ghest.

The deduction of these losses, it will be observed, brings the sidual water to about the amount normal to serpentine.

Such were the conclusions I had arrived at when the receipt of a x of Irish serpentines from Professor King, containing specimens the "saponite veins" of Cornwall, collected by himself, enabled e by analyses to speak with more precision on the matter.

The specimens of the Cornish "saponite" were at once seen to be ysically very similar to the paler-coloured vein-serpentines of Port-y. Being apparently somewhat weathered they were opaque, and e girasol appearance could not be seen.

A weathered vein from the serpentine of Polmally, in Glen Urqu-rt, which was very similar, was analysed along with this Cornish ponite.

It is not necessary here to quote more than the content of water, d loss thereof at 212°: this was—

	Total water.	Loss at 212°.
Mineral from Cornwall	14·133	1·166
,, ,, Polmally	15·162	1·626

This, taken in conjunction with a general accordance with their her components, shows that these specimens are similar to other in-serpentines, and are quite distinct from the mineral which occurs volcanic rocks.

As the specimen sent by Professor King is quite similar to othe smaller ones which I have seen in the Lizard serpentine, there every probability that the mineral analysed by Klaproth, Svanberg and Haughton was the same; and that of the substances classed unde the head of saponite by Dana, only those narrated as filling geodes i volcanic rocks properly fall under the title.

Supplement to Chlorite.

I have lately observed what I believe to be a chloritic mud occurrin in a form in which it bears a great resemblance to glauconite.

The circumstances of its occurrence are of much interest, and th explanation of these circumstances is attended with no small amoun of difficulty.

Immediately to the north of the village of Callander there is a cli of conglomerate of the Old Red Sandstone; this is here formed o nodules, from the size of a walnut to that of the fist, of gneiss, mi slate, and quartz,—rocks of the immediate neighbourhood.

Rarely, thin interstrata of a finer almost of a sandy grain,—mor fitted for building purposes,—occur to the north-eastward of th village.

In several small quarries, opened with a view to work these gritt beds, the characters of the conglomerate may be studied. It ha somewhat of a vitrified aspect, and is more broken up by "backs" and "cutters" than is usual to that rock. The dip is to the north-east; the backs run along the strike at distances of about six feet from each other; while the cutters, lying generally at right angles thereto, are much more closely adjacent to each other.

The backs, in those cases in which they have stood open, are invariably filled with one of the varieties of the substance to which the names of *reddle*, or *keely* or *keels* has been attached: the cutters are as invariably lined, and usually no more than lined, on each side with sheets of cockscomb barytes, which sometimes carry vitreous copper, malachite, and calcite.

The dull red of the vertical sheets of reddle is everywhere besprinkled with spots and blotches of a vivid green, of the colour of glauconite,—these spots are circular in form, or consist of a number of confluent circles, each circle being of about the size of a large bean.

The contrast of these colours is so striking as to arrest the attention of the passer-by; it is found upon examination to be due to the occurrence in the pseudo-vein of reddle, of "concretions" of granular pale purple carbonate of lime, of a discoid form; and to these concretions

being invested by the glauconite-like material, disposed in a laminated manner.

Portions of the calcareous concretions,—of their green coating,—and of the reddle, were examined in the laboratory, after isolation each from the others.

The concretions did not appear to have any structural arrangement of particles, being similar to a very fine-grained saccharine marble; they dissolved readily and totally in acid, without leaving any save a glauconitic residue; and neither they nor their associates contained any trace of baryta.

The glauconite-like matter was found to be insoluble in all acids; but after treatment therewith and agitation in much water, it separated into minute colourless pearly scales (like mica), and a green powder, which was also minutely scaly.

The reddle had a laminated arrangement of its particles parallel to the sides of the vein; it resembled a red sandy clay, and glistened with minute scales of mica. Treated with chlorhydric acid it yielded readily a ferruginous solution, but left behind the greater part of its bulk as a green powder, similar in appearance, and also in its insolubility similar to that which presented itself originally with a green hue.

From the evident admixture of scales of mica, it may be doubted if an analysis of these green powders — probably identical — would definitely disclose their nature; but the above chemical features sufficiently show that they cannot be any one of the saponites, unless it be celadonite, and their being the latter is contradicted by their scaly structure.

Their insolubility in acids equally proves that they cannot be glauconite; and, having regard to the occurrence in the conglomerate of quartz nodules with a chlorite which is very similar to that of Cruach Ardran and the hills surrounding it, there is every probability that the green portion consists of chlorite alone.

While the impurity of this substance prevents a more accurate determination, enough has probably been attained to, in the direction of indicating several points of marked interest connected therewith.

The following questions present themselves for being answered :—

By what process were these veins filled? The ready reply,—neither by infiltration nor injection, but by exfiltration,—goes but a little way. Conglomerated rocks are more pervaded by a system of *inosculating holes* than by fissures,—but I broke many pieces of the rock without being able to detect in its cavities any green matter in the course of

being transported to its resting place in the vertical rents; but an exfiltration of reddle-like matter may be observed, and this may obscure a concomitant chloritic transfusion.

Then, *What is the action whereby the segregating calcareous matter repels the hematitic,*—thus operating as a pseudo-bleacher?

And lastly, *How comes it that the one set of rents are lined with baryte, with vacuous interspaces; while that which lies at right angles thereto contains no trace of baryte, but is totally filled with a clay-like material?*

An explanation which may be said to lie upon the surface—namely, that the first mentioned set had been of earlier formation, and had been the seat of a process which had reached its termination before the formation and filling up of the latter,—does not meet the facts of the case, because the rock-rents which form the "backs" seem to have been antecedent to those existing as "cutters"; for the former pass numbers of the latter, while these but very seldom cut across the former.

The rock seems to be *still* purveying hematitic and chloritic matter to the cracks which form its "faces";—*is there a polarity in the guidance of its decomposition,* acting so as to fill its minor and secondary rents with barytes and with copper,—enabling them at the same time to reject the slimy plug which chokes the backs, that they may at least aspire to the dignity of being true mineral veins?

Some questions of weighty mining import might possibly be answered through a study of this narrow field;—the points of chief mineralogical interest are the occurrence of a chloritic mud in a form simulating glauconite,—and the singular manner in which a large quantity of chlorite may be entirely masked by a comparatively small quantity of peroxide of iron."

REINITE (*Neues Jahrb.* 1879, *Heft*, 3, 4. *page* 286 *oder Zeitschrift f. der NaturwissenSchaften in die Provinz. Sachsen und Thuring.* 1879, has been so named by K. von Fritsch after its discoverer Professor Rein, who found it at Rei Japan; it has been described by O. Luedecke. Reinite occurs with large contemporaneously formed quartz crystals, of which many exhibit a beautiful fracture according to + R. For investigation one large crystal was employed: form tetragonal, the fundamental pyramid (111), whose polar angles were very slightly truncated by the pyramid of the second order (101). The appearance of large sub-crystals with the axis inclined to the chief crystal is frequent. The polar angle (111) : ($1\bar{1}1$) is 103 32′. The relation of the axis $a : c$ is as 1 : 1·79 : the angle (111) : (101) was

measured as 141° 15′—14° 30′ with the hand goniometer. H=4, Sp. Gr.=6·640; cleavage imperfect (110); fracture uneven; color dark-brown; streak brown; lustre vitreous-metallic; opaque. Before the blowpipe behaves itself according to N. H. Rose, like a Wolfram containing a large amount of iron. H Cl, HNO_3, and H_2SO_4, do not decompose the tungstate of iron even when boiling.

Composition according to E. Schmidt:—

Ferrous Oxide	24·33
Tungstic Acid	75·47
Lime	a trace
Magnesia	,,
Tantalic Acid	,,

Reinite is therefore pure tungstate of iron with the formula $FeWO_4$ and is connected in its chemical relations with Hübnerite and Wolfram. As tungstate of iron and tungstate of manganese both crystallise in monoclinic forms, so their simple union must also be monoclinic, which is the form assumed by Hübnerite. As also the tungstate of iron, as Reinite has arranged itself in five symmetrical planes, so it is to be assumed with every probability that the tungstate of iron as well as the tungstate of manganese are isodomorphous.

T. A.

Heldburgite.—(*Zeitschrift für die gesammten Naturwissen Schaften Bd.*, II, *Heft* 2, *page* 291, 1879.)—In the felspar of the Phonolite of Heldburg in Coburg, O Luedecke discovered a few fragments of minute columns associated apparently with Zircon, the largest of which was 3 mm. long, ⅓mm.—½mm. thick. Crystalline system tetragonal: Combination of (110) (100) (111.)

Values the of following angles were measured and calculated:—

	Measured.	Calculated.		Difference.
$(1\bar{1}1) : (\bar{1}11)$ ..	86° 40′ 8	86° 37′ 5	+	3′ 3
$(\bar{1}11) : (\bar{1}10)$ ..	136° 37′ 5	136° 41′ 2	—	3′ 7
$(\bar{1}10) : (\bar{1}1\bar{1})$ ..	136° 44′ 1	136° 41′ 2	+	3′ 9

The relation of the axis *a* to the principal axis $c=1 : 0{\cdot}7500$, or as 4 : 3, measurements approach those of Zircon and Oerstedite. External characters resemble those of Guarinite. Hardness less than steel; color yellow; streak white; adamantine lustre; transparent; before the blowpipe infusible; chemical composition unknown; titanic acid absent.

T. A.

HERRENGRUNDITE.—[*Urvölgyite.*]—*Min. und Pet. Mitt. Tschermak's Band II, Heft III and IV, p.* 311—324.)—This hydrated cupreous sulphate of lime, from Herrengrund (Hungary) was briefly referred to in the last number of the Mineralogical Magazine. It occurs in an unworked part of the copper mines of Herrengrund (Urvölgy) near New Sohl in the N.W. of Hungary. It was at first taken for Brochantite and for Langite.

Morphological relations :—The mineral forms laminated groups dark-green to bluish in colour, upon a yellow-quartz conglomerate. These groups are so symmetrical that they present ball-like aggregates with rough surfaces and dark-green satin-like lustre. Single crystals do not occur: but the lamellæ can be examined separately and shew striking parallel lines which at their terminations experience a truncation, at their sides a bevelling. With the plane of the lamellæ the truncated surfaces form right angles, with each other an angle of 130° approximately. Cryst. system Rhombic, the parallel lines correspond to the brachydiagonal; plane of the lamellæ, the basal pinakoid OP: the two truncated surfaces which touch in the brachy-diagonal axis the prism surfaces ∞P; whilst the bevelled surfaces represent the brachydome $P\breve{\infty}$. In this way the combination 0P, ∞P, $mP\bar{\infty}$ is formed. According to Schafarzik the angles $0P : mP\breve{\infty} = 130—131°$; mP 102°. According to Winkler the angle $0P : P\breve{\infty} = 130\frac{1}{2}—131°$. Besides the surfaces in this dome another surface appears without a corresponding one on the opposite side, which gives to the combination a monoclinic aspect, though the cause of the defect is dependent not on the imperfection of the developement, but is produced by unequal central distance. According to Dr. Brezina however, the crystalline system is monoclinic with a slight angle.

Elements : a : b : c = 1·8161 : 1 : 2·8004, $\beta = 91° 9' 5''$.

Optical relations: In revolving the Nicol very much dichroism—bluish-green, greenish-yellow. With the crossed Nicols the maximum of extinction occurs in the direction of the parallel lines: if a thicker lamina be taken, an axis image appears on the plane, consequently the mineral is biaxial, the axis lying in the plane of the brachydiagonal section: axis angle great: both images perfectly symmetrical: dispersion of optical axis $\rho \angle v$. The bisection occurs with the principal axis, and consequently the optical peculiarities favour the view that it belongs to the rhombic system. With polarised light the thin plates shew strikingly those colours conditioning dichroism: thicker plates on the contrary shew a lively play of colors, and from these experiments it is evident twinning frequently occurs—the twin planes being parallel with the brachydiagonal.

Lustre and color.—Both are of two kinds, vitreous, and mother of pearl like: dark emerald-green to a bluish sea-green. Glassy lustre at peripheral surfaces, and in those of the less bent laminated aggregates occasionally a peculiar coppery lustre. Plane 0P seen obliquely shows a mother of pearl lustre; whilst on a thin lamina it is vitreous at the peripheral surfaces dark-green; in the plane of the laminæ a blue to light-green colour, but some varieties have only a uniform dull greenish-blue colour.

Cleavage.—In three directions, most perfect in the plane of lamellæ, and if heated this takes place in thinner leaves also. Cleavable in the direction of the brachy-diagonal. When rubbed between the fingers it breaks up in this plane, and in rare cases cleavage is seen parallel to the surfaces of the prism. Cleavage accordingly 0P perfect; $\infty P\breve{\infty}$ perfect; ∞P imperfect. Hardness 2·5—3; density 3·132 (Winkler.)

Composition :—

H_2O	16·726
CuO	42·520
CaO	8·587
$S\,O_3$	24·620
SiO_2	0·332
FeO	0·142
Mn. Mg	(traces)
	99·927

Position in the mineral system:—It must be placed near Brochantite, Langite, Linarite, and Cyanotrichite, but it is most closely allied to the first two, as indicated by the physico-chemical distinctions now to be spoken of. Brochantite in powder under the microscope always appears green without a trace of blue; Langite on the contrary pure blue, thicker masses deep blue, thinner azure blue, at the most with a shade of green. Herrengrundite in thick fragments is emerald-green, yet never possessing the intensity of brochantite; in thinner layers it is greenish-blue. It is distinguished, however, by its chemical relations. By the wet method, all three are soluble in HNO_3 and give with excess of ammonia an azure-blue solution, in which a drop of oxalic acid produces a white precipitate with Herrengrundite, but none with Brochantite or Langite. The flame reactions are still more characteristic, Brochantite and Langite give only the blue-copper flame, whilst Herrengrundite gives both the yellowish-red lime flame and the blue copper flame. Cleavage of Brochantite under the microscope has been observed in three directions. In Langite the optical axes lie in the brachy-diagonal section;

the observed combinations nearly agree; the three species are tr very nearly allied.

Paragenetic relations :—Herrengrundite about 1 mm thick is fou covering a bed of finely granular white gypsum, and is of two kinds an earlier and a later formation; the later is a dark-green, strong shining mineral, its normal condition—the older is dullish-blue, a appears to be covered with a white powder. The occurrence of t mineral with gypsum is significant, but still does not appear to suffi for the formation of the cupreous sulphate of lime. Here th hydrated sulphate of copper and the constituent parts of gypsum ha crystallized together in such a way that the Brochantite Langite substance maintains a preponderating influence, and th maintains also the rhombic type. On the other hand if, accordi to Prof. Schenck we group the molecular relations as 6 H_2 4 CuO, 2 SO_3, 1 CaO, next withdraw a molecule of gyp (CaO, SO_3 + 2 H_2O) the remainder may be combined the following way, 3 CuO, SO_3 + CuO H_2O + 3 H_2O formula showing that Herrengrundite is more nearly al to Langite than Brochantite. A fact still more clearly brought is the composition of Herrengrundite, from which it may considered that a molecule of Langite and a molecule of gypsum h crystallised together, which may take place with the basic hydra sulphate of copper on separating from a water containing gypsu From the experiments of Schenck of Schemnitz, it appears that t gypsum of Herrengrundite dissolves in 3000 parts of water, *the wate crystallization of Brochantite, and only a very small quantity of Brochant* The question now arises here is the Gypsum and Brochantite contai in Herrengrundite. Is it a mixture or a double salt? In favour of being a double salt the fact exists that the percentage of sulphuric a goes half to the gypsum and half to the Brochantite. Investigations al evidently show that the mineral is to be regarded as a product of t crystallizing together of gypsum and a substance like Brochantite Langite, exhibiting at the same time its easy decomposition and mo of dissociation under the action of water and dilute muriatic acid. In chemical experiments also the individual peculiarities of gypsum a Brochantite always appear: then the striking peculiarity is seen, th nitric acid dissolves the Herrengrundite without a gypsum precipitat whilst muriatic acid does not: the explanation being that the nitr acid is a better solvent of gypsum than the muriatic. But bo hydrated sulphates manifest a strong tendency to crystallise togeth which in different relations can take place apparently in varying p portions—the green color being more connected with the Brochanti the chemical composition and optical peculiarities with the Langite.

From further investigations into the occurrence of these hydrated carbonates of copper, the paragenetic relations may be stated as follows, commencing with the youngest member:—1st α *Herrengrundite* bright shining emerald-green, forming considerable masses. β *Herrengrundite* dull bluish-green substance, similarly grouped aggregates formed of minute laminæ. *Azurite* forms single granules. *Malachite* as a botryoidal crust of fibrous structure. *Pitticite* amorphous, blood-red, very rare. *Gypsum*, short white fibres, in rare instances forming layers from 10-12 mm. thick.

Herrengrundite is derived from tetrahedrite and chalcopyrite, both of which occur in layers in scattered patches in the quartz conglomerate of the district. It has also been found at Erbstollen, in small amount. At the depth of a metre below it water was found. Herrengrundite has also been seen directly in contact with coarse tetrahedrite, though it is usually found upon gypsum or malachite.

The veins at Herrengrund occur in grauwacke and mica schist, the latter being the under, the former the upper layer, above which a triassic limestone is met with, in which the veins show no continuation, though it may have supplied the lime for the formation of the gypsum.

T. A.

ON A NEW PROCESS FOR THE MICROSCOPIC STUDY OF VERY MINUTE CRYSTALLINE GRAINS (M. J. THOULET, *Bull. d. l Soc. Min. d. France, II*, 7).—The author embeds the particles of mineral in a cement, which, when set, he slices and polishes for microscopic examination. The mineral powder, to be examined, is mixed with ten times its volume of oxide of zinc, and enough silicate of soda (or preferably, of potash) is added to make a thick paste. This paste is then transferred to a mould, made by laying a thin ring of glass upon a sheet of paper. In a few days the mass will have set hard, and can be removed from the mould, ground, and polished like a natural rock, as it possesses great tenacity. On examination under the microscope, the sections of mineral that it contains are easily distinguished in the midst of the surrounding opaque material.

H. L.

ON A NEW PROCESS FOR TAKING THE SPECIFIC GRAVITY OF A MINERAL IN MINUTE GRAINS (M. J. THOULET, *Bull. d. l. Soc., Min. d. France. II*,).—The first stage of this process is the preparation of a float of wax, containing a minute fragment of some mineral, so that the sp. gr. of the whole shall be between 1 and 2; the author employs a splinter of orthoclase and surrounds it with wax, till it forms a mass of about the

size and shape of a grain of wheat, which has then to be carefully weighed. The fragment or fragments, whose sp. gr. is to be taken and the weight of which is exactly known, are attached to the float by a gentle pressure of the fingers. The whole is then immersed in a solution of iodide of mercury in potassic iodide, and the solution gradually diluted with water until it has exactly the same sp. gr. as the float, which may be known by the latter neither rising nor sinking in the solution. The sp. gr. of the solution is now taken; let it equal Δ. The float is taken out of the solution, washed, and the fragment of mineral carefully removed with a forceps. The float is returned to the solution and water is added, till the sp. gr. of the float and solution are again equalised. The sp. gr. of the solution is then once more determined; let it equal D. Then P being the weight, V the volume and D the sp. gr. of the float,

$$V = \frac{P}{D}$$

If p be the weight, v the volume, and d the sp. gr. of the mineral

$$v = \frac{p}{d}$$

and Δ being the sp. gr. of the float with the mineral attached,

$$\Delta = \frac{P + p}{V + v} = \frac{P + p}{v + \frac{p}{d}}$$

$$\text{whence } d = \frac{p\,\Delta}{P + p - \Delta V}$$

H. L.

ON A NEW MINERAL SPECIES, DISCOVERED IN THE DISTRICT OF GUEJAR, SIERRA NEVADA (M. E. CUMENGE, *Bull. d. l. Soc., Min. de France, II*, 7).—This mineral, which has been named Guejarite by the discoverer, occurs well crystallised in a veinlet of spathic iron ore. The following is its analysis :—

Sulphur	25·
Antimony	58·5
Copper	15·5
Iron	0·5
Lead	traces.
	99·5

These figures correspond to the formula $2\,Sb_2\,S_3$, $Cu_2\,S$, the small quantity of iron found being due to a slight admixture of copper pyrites.

The mineral occurs in brilliant crystalline plates, 20 mm. long and 7 mm. broad; its color is steel-grey; sp. gr. 5·03; hardness 3·5.

M. C. Friedel has investigated the crystallisation of Guejarite. He finds that it belongs to the rhombic system. The prism (100) is the predominating form, a distinct cleavage being parallel to it; numerous other prisms, several brachydomes and the basal plane (001) also occur. The angle (110) $(\bar{1}10)$=101° 9′ 12″, and the relation between the parameters is—

$$h : D : d = 0{\cdot}7841 : 1 : 0{\cdot}8220.$$

Guejarite is thus isomorphous with Wolfsbergite ($Sb_2 S_3$, $Cu_2 S$) in which species the angle (110) $(\bar{1}10)$=109°

H. L.

On the Microscopic Examination of some Natural and Artificial Spinels (M. J. Thoulet, *Bull. d. l. Soc., Min. d. France, II,* 8.)—The following is a list of the spinels examined by the author:—Artificial spinels, for the most part prepared by Ebelmen: chromite, chromite of manganese, chromite of magnesia, chromite of zinc, chromite of lime and glucina, ferrite of zinc, ferrite of magnesia, hausmannite, aluminate of iron, zinciferous spinel, and aluminate of zinc.

Natural spinels: Chrome iron-ore, hercynite, automolite, creittonite, franklinite, and pleonaste.

Each specimen was examined under the microscope, its specific gravity taken whenever possible, and its magnetic powers noted; the following are the chief conclusions thus arrived at by the author.

(1.) The greater the amount of iron in a spinel, the less is its transparency.

(2) All spinels, when reduced to the thickness usual for microscopic observations are transparent or translucent, except magnetite, which is entirely opaque; thus hercynite, franklinite, hausmannite, creittonite, and chromite are translucent, though stated by Dana to be opaque.

(3.) All spinels have under the microscope a shagreen-like surface, and this character is more clearly marked the greater the hardness of the mineral; this rough surface does not appear in quartz and in substances softer than quartz.

(4.) No chrome iron or chromite is magnetic; such specimens as show magnetism, owe this property to an admixture of opaque grains, which appear to be magnetite.

(5.) The natural spinels known as hercynite, creittonite, and gahnite, are more or less mixed with oxide of iron; this explains the varying proportions of iron found in different analyses.

(6.) Ebelmen has remarked that in preparing artificial chrome spinels, the crystals first formed are the most strongly coloured by

chromic-oxide. The microscopic examination of chrome iron-ore co firms this observation, showing ferriferous grains, more or less opaqu agglomerated round the translucent yellow ones; a kind of liquati of the material richest in chromium has taken place, this being fi isolated and surrounded by a series of minerals richer in iron, a terminated by magnetite.

(7.) The anisotropic action of the chromite of glucina and lim closely related to the polarising properties of cymophane or alumina of glucina gives support to the theories which tend to show that gluci is a sesquioxide.

H. L.

ON THE DEHYDRATION-ELLIPSOIDS OF RHOMBOHEDRIC CRYSTALS (*Schncke, Zeitsch, f. Kryst., u. Min., P Groth, IV*, 3).—According some experiments made long ago by Mr. Pape, when a crystal, into composition of which water enters, is heated, spots of decomposit (dehydration) are formed on the various planes, which spots gener shew an elliptical outline, being in fact such figures as are produced the intersections of the respective planes with an ellipsoid which characteristic of each crystalline body, and occupies a constant posit with reference to the axes of the crystal. Supposing the decomposit to start from the centre of the crystal, it will usually extend with u equal rapidity in different directions, the surface of the dehydrat portion forming at each moment an ellipsoid, the dehydration ellipso This behaviour corresponds to that of the conductivity for heat, and several other properties of crystals, each of which may be represent by the radii vectores of an ellipsoid as a function of the directi But Mr. Pape has observed one startling difference, namely that rhombohedric crystals the dehydration-ellipsoid is a sphere, whilst t other properties are represented by ellipsoids of rotation, the axis rotation being parallel to the main axis. These observations we made on three substances :—

Plumbic dithionate	($Pb S_2 O_6 + 4$ aq.)
Strontic dithionate	($Sr S_2 O_6 + 4$ aq.)
Calcic dithionate	($Ca S_2 O_6 + 4$ aq.)

The author of this paper has re-examined the results obtained Mr. Pape, and, after very numerous observations, finds that the surfa of dehydration of the above-named rhombohedric salts is not a sphe but is a very close approximation to an ellipsoid of rotation. T method of experimenting was the following :—The crystals we heated in a hot air bath, and as soon as small spots of dehydrati (usually between 0·02 and 0 04 mm. in diameter) were produced, t

crystals were removed, and the major and minor axes of the ellipses measured by means of a micrometer. The author gives at length the numerical results obtained, and finds therefrom that the first-named salt has an elongated dehydration-ellipsoid, the ratio of the vertical to the horizontal axes being 11:10, whilst the two latter salts have a compressed dehydration-ellipsoid, the ratio of the axes being approximately 10:12.

H. L.

On Sericite (*H. Laspeyeres, Zeitsch. f. Kryst u. Min., P. Groth, IV*, 3).—Numerous authorities have attempted to show that Sericite is a separate mineral species, but the author of this paper contends that it is merely a massive potash mica He analysed it by boiling the finely divided mineral for several hours a day during 5 months in pure hydrochloric acid; 19·021 per cent. was left unattacked, being principally quartz, and the decomposed mineral was found to contain—

Silica	45·361
Alumina	32·919
Ferric Oxide	2·048
Ferrous Oxide	1·762
Lime	0·494
Magnesia	0·895
Potash	11 671
Soda	0·724
Water	4·126
	100·000

The composition agrees well with that of a potash mica, and this view of the constitution of Sericite is moreover supported by a careful examination of the physical properties of the mineral.

H. L.

On Arseniates from the Joachimsthal (A. Schrauf, *Zeitsch. f. Kryst., u. Min., P. Groth, IV*, 3)—*Mixite* a new hydrated arseniate of copper and bismuth. This mineral occurs in the so-called "Geisergang," at a depth of 20 metres, and was found by Mr. A. Mixa. Its mineralogical characteristics are as follows:—Color, emerald-green to bluish-green, streak somewhat paler; hardness 3-4; sp. gr. 2·66; the most delicate fibres are almost transparent. The mineral occurs as an efflorescence on impure yellow bismuth ochre; in scattered grains; and in spherical reniform aggregations, granular in the centre, and concentrically fibrous towards the exterior, the fibres appearing under the microscope as six-sided prisms. The angle of the prism is about

55°, and as the direction of maximum extinction is inclined 6°—9° the edges of the prism, the crystalline system must be monoclinic triclinic.

The mineral is easily recognised by its behaviour towards dilu nitric acid; when immersed in it, it is immediately covered with a fil of a brilliant white powder of arseniate of bismuth, while the arsenia of copper enters into solution. The mean of three analyses gave:

Cu O	43·21
Fe O	1·52
Ca O	0·83
$Bi_2 O_3$	13·07
$As_2 O_5$	29·40
$P_2 O_5$	1·05
$H_2 O$	11·07
	100·15

The formula corresponding to this composition is Cu_{20}, Bi_2, As_{10}, H O_{70}, which may be rationalised thus:—

$$\left\{\begin{array}{l} 4\,(Cu_3\,As_2\,O_8 + 2\,Cu\,(HO)_2 + 3\,H_2O) \\ +(Bi_2\,As_2\,O_8 + 2\,H_2O) \end{array}\right.$$

The minerals that accompany mixite are various species of decc posed bismuth ores and Tennantite, mostly somewhat decomposed a containing some bismuth; chalcolite and bismuthite also occur wi it.

Wapplerite. The author gives a long series of goniometric me surements of this mineral, which justifies the assumption of t following system of parameters:

$$a : b : c = 1 : 1{\cdot}11002 : 0{\cdot}29037$$
$$a = 90°\ 13'\ 55'' \quad \beta = 95°\ 20' \quad \gamma = 90°\ 10'\ 35''$$

Good crystals shew a very close approach to monosymmetry, which ma be induced to some extent by twinning.

Wapplerite is distinguished optically by showing "dispersio croisée," the arrangement of the colors being the opposite to that whic obtains in the case of borax.

Pharmacolite. In addition to the planes already known to occur this mineral, the author has observed the pyramid $(11\bar{1})$; he gives a li of goniometric measurements of some crystals, and compares the angl found with those calculated, taking the following system of parameter $a : b : c = 0{\cdot}61373 : 1 : 0{\cdot}36223$, $\beta = 96°\ 46'\ 6''$. The results obtaine are fairly concordant.

H. L.

Davreuxite (M. L. L. de Koninck, *Bull. de l' Acad. roy. d. Belg.* 2) 46 *No.* 8, *August*, 1878; *Zeitsch. f. Kryst. u. Min., P. Groth., IV,*).—This mineral was first found by Dumont in quartz veins in the lates of the Ardennes at Ottré, but was mistaken for asbestos; the uthor has found it in small quantities at Sart-close (Salm-Chateau.) t consists of very thin transparent needles, white to flesh-colored, ometimes containing a little admixed quartz. It is infusible in the Bunsen flame, and but slightly attacked by acids. The following is the nean of three analyses :

H_2O	4·19
SiO_2	55·94
Al_2O_3	33·59
Mn O	5·25
Mg O	1·10
	100·07

Traces of iron present.

The author estimates that $\frac{1}{6}$ of the material analysed consisted of quartz, and therefore subtracts 16·63 per cent. from the SiO_2 found by nalysis. He thus obtains for Davreuxite the formula H_4 (Mn. Mg.) $Al_6 Si_6 O_{18}$*

H. L.

On a New Resin from Köflach in Steiermark (by C. Dölter, *Mitth. d. naturwiss. Vereins f. Steiermark*, 1878; *Zeitsch. f. Kryst. u. Min.*, P. *Groth, IV*, 1.)—This resin occurs in layers about 1 inch in thickness n the Tertiary lignites at Lankowitz; color dark-brown; thin splinters eddish-brown, translucent; fracture conchoidal; sp. gr. 1·2—1·25. Soluble in ether and carbon disulphide, insoluble in alcohol and in austic potash.

Analysis after subtracting 1·90 per cent. of ash :—

C	82·23
H	10·28
O	7·49
	100·00

Formula $C_{29} H_{43} O_2$. Melting point 98°, but the resin softens at a ar lower temperature. Electric on friction. This resin is hence a etinite closely related to Jaulingite.

H. L.

* Thus in the German original the formula should read H_4 (Mn., Mg.) $Al_6 Si_6 O_{24}$.

NOTES ON MINERALS (A. VON LASAULX, *Zeitsch. f. Kryst. u. Min.*, P. Groth, *IV*, 2) —*Titanomorphite*—Amongst the gneissic rocks that form the crest of the "Hohe Eule" (in Silesia) there are numerous hornblendic rocks, some of which are so rich in garnets, that they may be called garnet-amphiboles. In a quarry of this rock there occur numerous nodules of rutile, varying from microscopic size up to that of a nut; each rounded nodule, composed at times of several closely coherent grains, is surrounded by a pale greenish white zone of a finely fibrous structure, the fibres being arranged radially and normal to the exterior surface, on approaching which they gradually assume a granular structure. The rutile nodules but rarely shew their characteristic brownish-red color; they are often quite black like Ilmenite, and contain an ochre-yellow kernel of rutile; they are of the variety of rutile known as nigrine, and consist, as has already been pointed out by Rammelsberg, of a mixture of Ilmenite with rutile. The thickness of the crusts of Ilmenite round the kernels of rutile is variable, and some specimens contain no kernels at all. All, however, are surrounded by the white substance above-mentioned, but in varying quantities. This substance has been referred erroneously to various mineral species, but the author has long supposed it to be a titanate of lime, and has named it Titanomorphite.

Titanomorphite forms as already stated granular fibrous aggregates, but even the minutest fibres are composed of rows of distinct granules. By means of exhaustive optical observations made on sections through some of the larger granules, the crystalline form of the mineral has been determined with some certainty. The mineral is biaxial and highly double refracting; it is optically positive; dispersion of the axes very strong; 2 E=45°—50°; thus agreeing very closely with the optical properties of Titanite; it is therefore monoclinic.

The following are the values of the principal angles in

	Titanite.	Titanomorphite.
$(001/\bar{1}02)$ ..	39° 17′	40°
$(001/110)$ ..	85° 45′	86½°
$(\bar{1}02/10\bar{1})$ ..	21°	19°—20°
$(10\bar{1}/110)$ ..	40° 34′	41¼°
$(110/1\bar{1}0)$ ..	46° 8′	45°—47°
$(123/12\bar{3})$ ..	43° 48′	43°—45°

These figures shew a very close isomorphism between the two minerals.

The following is an analysis of Titanomorphite, made by Dr. ettendorff :—

$Ti O_2$	..	74·32
Ca O	..	52·27
Fe O	..	trace.
		99·59

This composition agrees well with the formula $CaO, 2 TiO_2$; so that anomorphite is not only physically and optically isomorphous with anite, but their chemical compositions also correspond.

Titanite	$Ca Si_2 O_5 + Ca Ti_2 O_5$
Titanomorphite	$Ca Ti_2 O_5 + Ca Ti_2 O_5$

us affording a fresh instance of the isomorphism of titanic and licic acids.

Idocrase from Gleinitz and from the Johnsberg, near Jordansmühl ilesia).—Idocrase, forming incrustations of a yellow or peach-blossom lor, has long been known to occur on a decomposed mica-schist on e south-eastern side of the Johnsberg; the idocrase of Gleinitz milarly forms layers 1—2 inches thick, in serpentine, which layers nsist of columnar aggregates with well-developed crystals projecting to the cavities. These crystals are colorless or pale-greenish, rose id amethyst-colored; the latter color is, however, never spread over e whole crystal, but is confined to the polar extremities. The other rieties only shew a feeble dichroism, but the amethystine portions e strongly dichroic, being pale-green in the direction *c*, and peach ossom-colored along *a*.

When a section perpendicular to the axis is examined in parallel olarised light, the phenomena that have been described by Mallard pear, the square plane being divided into four equal, triangular gments; in convergent polarised light the crystals are seen to be uiaxial. Sections parallel to the axis shew that the crystal consists thin concentric layers. In this case the anomalous behaviour wards light is a sign, not of a pseudosymmetrical crystalline form, ut of an anomalous mode of growth of the crystals.

The following forms have been observed in the well-developed ystals :—

(1) ∞P (110), $\infty P\infty$ (100) P (111) $P\infty$ (101) o P (001) and $\infty P 2$ (20); the ordinary form of Idocrase from Wilni.

(2) Prisms predominating; prisms and a ditetragonal pyramid P 3) alone occur; rarely P, never oP.

(3) Pyramids predominating, prisms scarcely developed at all; only P, P∞ and oP occur. This is a very rare form.

The peach-blossom colored crystals from the Johnsberg are always of the first type.

The following are analyses of two samples by the author, No. I being that of the colorless crystals from Gleinitz, and No. II of the peach-blossom colored crystals from the Johnsberg.

	I.	II.
SiO_2	37·57	37·32
Al_2O_3	16·30	16 87
Fe_2O_3	1·82	2·57
FeO	2·76	2·38
CaO	36·26	34·46
MgO	1·75	0·67
MnO	—	3·23
Na_2O	not determined	—
H_2O	3·01	2·22
	99·47	99 72

It thus appears that the red tinge of the Johnsberg crystals is due to MnO, and this variety may therefore be designated a manganese-idocrase.

Gismondine from the basalt of Schlauroth near Görlitz. The author has undertaken an elaborate optical examination of some small pseudo-quadratic crystals, obtained from a geode in the above basalt. As the planes of the crystals did not exceed 2—3 mm. in length, and were too imperfect for goniometric measurement, optical examination had to be resorted to, to determine the crystalline system of the mineral. Sections parallel to the pseudo-quadratic base, parallel to an edge, and parallel to a diagonal of this base were examined.

Although the author has been unable to determine the ratios of the parameters, he has succeeded in arriving at the following conclusions: All crystals of Gismondine are twins of asymmetrical individuals, which latter consist of combinations of very simple forms; pairs of dome planes, and quarter pyramids, either by themselves or combined with the former. The twins are either simple interpenetration twins formed in accordance with the law: "twin-plane a brachydome," or else double twins obeying the above law, and the following: "twin-plane a macro-diagonal section." As the relations of the axes approach very nearly to those of orthoaxial symmetry, the twin forms show pseudo-rhombic or pseudo-quadratic symmetry.

The interpenetration groups from the Schiffenberg, described by Streng as consisting of six crystals, are thus in reality composed of twelve individuals, and the forms thus produced approximate very nearly to those of the regular system. In respect therefore to the mode of twinning, Gismondine evidently corresponds closely with Phillipsite and Harmotome.

The differences and divergencies between the angles of the pseudo-quadratic base, and those of the polar edges are caused by the different inclinations to the vertical axis of the two brachydomes, both of which can be planes of twinning; but more especially by the modes of combination of the planes which form the lateral pseudo-quadratic edges, and which condition their position.

The differences between the angles of Gismondi's Zeagonite are decidedly within the limits of the differences observed in Gismondine, and there is no doubt but that these two minerals should be considered to form only one species.

H. L.

On Perowskite (H. Baumhauer, *Zeitsch. f. Kryst. u. Min., P. Groth.* 7, 2)—The author has investigated the crystalline form of Perowskite from various localities by an examination of the figures produced by etching the planes of the mineral. The re-agents employed were hydrofluoric acid, bisulphate of potash, caustic potash, etc. He finds that perowskite is rhombic, the ratios of the parameters being 1 : 1 : 1·711, the principal planes being ∞P, oP (forming a pseudo-cube) P, $\breve{P}\infty$, $\infty\breve{P}\infty$, (forming a pseudo-dodecahedron), and 2 $\bar{P}\cdot\infty$, 2 $\breve{P}$, (forming a pseudo-octahedron). The twins are always extremely complicated, but P and ∞P appear to be the most commonly occurring twin-planes.

H. L.

Crystallogenesis.—(Chevalier Charles de Hauer, *Imp. Geol. Inst., Meeting January 13th*, 1880).—The presence of a small proportion of *borax* in a solution of *Sulphate of Magnesia* gives rise to uncommonly perfect and completely developed crystals, nearly all of them with hemimorphous terminations. When the proportion of borax is not excessively small, a second pair of planes appears at the pointed extremities, these however are always of very subordinate extension.

The form of the crystals is essentially different according to the proportion of borax in the solution, and becomes apparent by admixture of a very small quantity of this substance. When this proportion is considerable, the crystals of sulphate of magnesia

become notably harder, assuming the form of very shortened prisms so that the terminal surfaces nearly touch each other. Such crystals when adherent by one of their terminal surfaces, have the aspect of tetrahedra, which they keep when allowed to grow up to a considerable size. The crystals, formed in a solution containing much borax, are characterized by a great number of terminal surfaces especially when grown up to a notable size. Some of them have on one termination no less than eight surfaces. The proportion of borax in the solution being very great, the terminal surfaces of the crystals instead of being smooth and specular, are covered with hemispherical or circular prominences and shallow serpentine furrows, the prismatic surfaces remaining unaltered. These deformities disappear when the crystals are allowed to continue their growth within a solution containing a lesser proportion of borax.

What has been observed concerning the action of borax, likewise takes place when crystals are growing in a mixture of sulphate and chromate of magnesia, whatever the mutual proportions of these ingredients may be. Mixed solutions of sulphate of magnesia with sulphate of nickel or of cobalt in varied proportions give rise to green or red crystals, identical in form with those of unmixed sulphate of magnesia, and showing, when somewhat increased, all the irregularities and deficiences of their terminations as observed on those of unmixed sulphate of magnesia. The presence of borax acts likewise on the mixed solutions here in question, giving rise to well-developed crystals with hemimorphous terminal surfaces, preserving this character during their further increase. This, however, only takes place when in the mixed solutions, the proportion of sulphate of magnesia considerably prevails over that of the sulphates of nickel or cobalt. The addition of borax causing a precipitation of cobalt and nickel, some drops of a free acid must be added to the solution. The epi-isomorphous crystals, arising out of these mixed solutions in variable succession, are beautiful and easily obtained. In some of them, the sulphates of magnesia and nickel, of magnesia and cobalt, of magnesia and the sulphato-chromate of magnesia, are superposed on each other, and the pellucidity of these crystals is such, that the limits of the single strata are distinctly perceptible. The immediate contact of the solution of sulphato-chromate of magnesia with the crystals containing nickel or cobalt, must be avoided, which is done by allowing a stratum of pure sulphate of magnesia to be deposited on the surface of these crystals.

Chlorate and *Bromate of Soda.* The presence of some sulphate of soda in a solution of chlorate of soda provokes the formation of tetra-

idral crystals with the angles replaced by three-planes, and subordi- te hexahedral surfaces. When a hexahedral crystal of chlorate of da, with traces of hemihedry, is plunged into a solution of sulphate soda, it assumes soon the tetrahedral form in the course of its crease. When the proportion of sulphate of soda is considerable, e tetrahedral crystals show no traces of hexahedral surfaces.

Bromate of Soda is only obtained in a regular octahedral form, or in ch with somewhat prevalent threefaced octahedral surfaces. A solu- on of this bromate, mixed with as much of chlorate of soda as it will mit, produces only hexahedral crystals without any indication of mihedral surfaces. Each of these salts, separately treated, gives *nsparent* crystals, while those issuing from a mixture of both, are *que* and milk-white.

Crystals in solution of Isomorphous Substances. Saturated saline solu- ns take up notable quantities of some other salt without regard to ir different degrees of solubility. The saturated solution of a salt ves inactive towards the crystals of a substance isomorphous to it, en this last substance is less soluble than the salt contained in solution. Thus episomorphous crystals may be obained by in- ase within a solution of an isomorphous substance, while any other stals disappear when immerged in it.

Dr. Klocke asserts that, having shaken during a long time a stal of alum, immersed in the saturated solution of a more able variety of alum, he observed on the surface of this crystal roscopical etched figures. This fact proves again that crystallization s not proceed according to strict geometrical precision. Dr. Klocke vever, goes too far in his conclusions by parallelizing this minimum solubility with the mutual action of isomorphous salts, and by ying these last to be an exception to the general rule. This asser- n would at once annihilate a series of fundamental laws, deduced m experiments and observations, although their geometrically pre- concordance with facts cannot be proved.

COUNT M.

SPHERICAL CONCRETIONS. (G. WUNDT., *Imp. Geol. Inst., Meeting rch 2nd*, 1880.)—The dark-grey shaly clays of Vils (Tirol), ranked Gümbel among the "Allgäu" shales (Upper Lias), have proved their organic remains, collected by the late Prof. Oppel, to be ddle Cretaceous, coæval with the Gault.

The clays here in question, intercalated between two zones of assic marble, include spherical concretions, varying from the size walnut to that of a fist, grey, with rough surface and uncommonly

ponderous. They appear very compact and hard, as a compound of sand and cement. Crystalline aggregations form their superficial crust when broken, the transverse section appears grey, compact or fine grained, occasionally somewhat crystalline and bright, like fine grained dolomite; the centre is generally a coarse crystalline white nucleus, from which occasionally radial fissures proceed to the outer crust. The stratification of the beds including these concretions, is undisturbed although similar disturbed and upheaved beds likewise include concretions. These last ones being neither crushed nor deformed, they must be inferred to have come to existence subsequently to the violent disturbances undergone by the strata. The uncommon weight of these concretions reminds one of the spheröidal concretions of phosphate of lime in the Cretaceous rocks of Russian Podolia; they are, however, only compounds of carbonate of lime and of gypsum.

COUNT M.

Gymnite of Pregratten (Tirol). (Chevalier Fr. de Hauer, *Imp. Geol. Inst., Meeting February 17th*, 1880).—This mineral appears under the form of a very thin, earthy, light-green crust, on Serpentine, reminding one of the Gymnite on the surface of chromates of iron from Texas and Alt-Orsova (Croatia). A qualitative analysis manifested the presence of nickel and water, with silica, magnesia, and alumina as accessory constituents, but no trace of cobalt. The gymnite from Pregratten, seems to stand next to the variety from Michipicoten which, according to Hunt, contains 8 per cent. of alumina; and like this, it is very soft.

The nickel-gymnites of Alt-Orsova, and of N. America appear associated with Chromite; the variety from Pregratten appears as a superficial crust on dark-green serpentine, with granules of magnetic oxide of iron, and with mere traces of chromium. A green mineral ("Emerald-Nickel") had been found long ago at Pregratten in the form of a crust in the fissures of larger crystals of magnetite interspersed in decomposed chrysotile. According to Petersen, the oxide of nickel may be derived from the olivine, transformed into serpentine and chrysotile.

COUNT M.

Witherite from Peggau (Styria). (M. C. Doelter, *Imp. Geol. Inst., Meeting March 2nd*, 1880.)—It appears in the form of crystals rarely exceeding the length of 5 millimeters, on compact Witherite (Carbonate of Baryta), separated from quartzose limestone by bands of brown crystalline sulphuret of zinc. The form of the crystals is P 2P ∞ oP, with a somewhat vaulted basis, and depressions on the pyramidal surfaces.

COUNT M.

Tertiary Eruptives of Schemnitz, Hungary.—*Greenstone Trachytes (Propylites)*.—(Dr. E. Hussak, *Imp. Geol. Inst.*, meeting March 2nd, 1880).—They are highly decomposed, their fundamental substance is compact, light or dark greenish-grey, interspersed with white decomposed felspar, amphibole, and light-green decomposed pyroxene. Microscopical investigation shows a micro-crystalline structure, greenish amphibole or mica, decomposed into calcite or epidote, highly decomposed plagioclase with abundant particles of calcite, and monoclinous felspar; apatite is scarce, and pyroxene is always wanting. These Trachytes closely resemble the so-called "Ancient Diabasic Porphyries"; they belong, however, decidedly to the Tertiary Eruptives. A variety of them includes pyroxene, decomposed into a viridic substance, less frequently into calcite or epidote, iron pyrites in abundance and titanate of iron, entire or decomposed. Other varieties include quartz, alone or with pyroxene.

Grey Trachytes (*Amphibolic Andesites*).—They are light-grey, whitish, reddish or brown, with undecomposed vitreous felspar, large prisms of black amphibole and lamellæ of mica. The microscope shows the fundamental substance to be composed almost exclusively of felspar, with a slight proportion of a granular vitreous substance. The unaltered plagioclases include an abundance of vitreous substance, together with prismatic crystals of pyroxene and apatite. Tridymite is not of rare occurrence, titanite is entirely wanting. The amphibolic andesites, like the micaceous ones, include a notable proportion of light-green, very dichröitic pyroxene. One variety has a totally vitreous or sphærolitic brown or uncoloured fundamental substance, abundantly interspersed with brown amphibole, mica, and light-green dichröitic pyroxene.

Dacites (*Andesites with Quartz and Amphibole*).—They are very abundant in pyroxene; their fundamental substance is composed of plagioclase and pyroxene, interspersed with amphibole and mica. The quartz includes a vitreous substance. Another variety is a genuine dacite, whose prevailing components are large fragments of brown amphibole, brown mica, undecomposed plagioclase and irregular granules, including a vitreous substance.

Younger (*Pyroxenic*) *Andesites*.—This variety, formerly ranked among grey trachytes or basalts (*Beudant's* "Trachyte semi-vitreux") has by far the greatest extension in the environs of Schemnitz. They are plagioclase-pyroxenic rocks without any olivine. The fundamental substance consists of interwoven microliths of pyroxene and felspar, either grey or filled with a brown vitreous substance, in which granules of magnetite are abundantly distributed. These microliths are either narrow and lengthened, or short prisms, or rounded. The

plagioclase is constantly undecomposed, bright, uncommonly abu
dant in vitreous substances, of distinct zonal structure. T
pyroxene, generally undecomposed and light-green, appears in t
well-known form of octangular transverse sections, the pinacö
generally prevailing over the prisms; it is highly dichröitic.
is rarely decomposed into viridite or bastite. This last mode
decomposition proceeds from transverse fissures, and is manifest
by the formation of green longitudinal fibres. Vitreous substance
included in uncommon abundance; microscopical tridymite and sm
rounded sphæroliths are of local occurrence. The red rocks, spott
with black, of the Ceykowa Valley, described by Baron Andri
(*Ann. Imperial Geological Institute*, 1866, p. 396), are genui
pyroxenic andesites, locally penetrated with oxide of iron, whi
forms a pellicle over nearly every one of the microscopic crystals
pyroxene of the fundamental substance. In this substance, bright bl
fragments alternate with red ones of euritic appearance. Vitre
substance is abundant; while vitreous felspars and microscop
prisms of black pyroxene are interspersed. The proportion of si
in the rocks here in question varies between 57 and 61 per cent.

COUNT M.

Correspondence.

A Member writes with reference to Capt. Marshall Hall's query in the last number of the Mineralogical Magazine:—

"As far as the problem is concerned I hardly know what to say. I have inquired after a Bordas circle and find that a number of geodesic instruments of different construction and use go by that name, none of which I have ever come in contact with. A Theodolite could of course be used for measuring crystals, but as there would be no means of centreing or adjusting the crystal, nor any independent axial movement, the measurements would necessarily be cumbersome and inexact. (Either the horizontal or the vertical circle could be used). I do not think it would be advisable to adopt a theodolite for crystallographic work, as the cost of such an alteration would be considerable compared with that of a small goniometer capable of excellent work, and now to be bought for a very small sum."

Obituary.

The Rev. James Clifton Ward, F.G.S., an associate of the Royal School of Mines; formerly an officer of the Geological Survey of England and Wales, one of the original members of the Mineralogical Society and a contributor on several occasions to the pages of the *Magazine*, died at Aydal on the 15th April, aged only 37.

An experienced and energetic field geologist, a fair chemist, a skilled petrologist, a zealous antiquary, an enthusiastic naturalist, a practised lecturer, he was the author of many original papers on geological subjects, more especially relating to Cumberland and Yorkshire.

He will be especially missed in the Lake district, where he had succeeded in overcoming local jealousies among the scientific and antiquarian societies of the county, and in establishing their joint action as the "Cumberland Association."

Short as was his life he has left his mark in the field of Science—and more espeeially in relation to the Lake district, and what may be called Wordsworth's country.

In David Thomas Ansted, F.R.S., F.G.S., &c., for many ye Professor of Geology at King's College, London, the Mineralogical Soci has lost another of its original members, who took great interest in work, but who, from increasing age and infirmities desired to be excu from partaking of its labours.

Professor Ansted was born in London, in February 1814, and died Melton, Suffolk, on the 20th May, 1880.

As the author of standard works on geology and physical geograp Professor Ansted enjoyed a more than European reputation, and in capacity as Assistant Secretary of the Geological Society, an office wh he held for many years, he became personally acquainted with nearly the geologists of his day.

For some years his work had been chiefly confined to practising as consulting geologist and mining engineer, and his death leaves a bla which it will not be easy to fill up in the ranks of the professio geologists.

Professor W. H. Miller, F.R.S., the eminent crystallographer w not a member of the Mineralogical Society although he frequen expressed his great interest in its work and progress. He died at Ca bridge, on the 20th May, in his eightieth year. His great and importa "Treatise on crystallography" now almost universally adopted by cry allographers, was first published in the year 1838.